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ON

FRACTURES AND DISLOCATIONS

BY

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DRAWN BY B. KEILITZ.

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AND ADDITIONAL ILLUSTRATIONS

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TRANSLATOR'S NOTE.

The work has been divided into chapters, and an index added; several additional illustrations are also inserted. The notes to the text are in all cases by the translator.

J. H., Jun.

ON FRACTURES AND DISLOCATIONS.

CHAPTER I.

GENERAL CONSIDERATIONS ON FRACTURES.

In speaking of fractures we have first of all to distinguish between those produced by external violence (traumatic fractures), and those which arise either without any external injury, or from such slight force as would not suffice to break normal bones (spontaneous fractures). Spontaneous fractures are the result of a fragility which as a rule is caused by tumours (sarcoma, metastatic carcinoma, hydatid cysts, &c.), or by inflammatory disease of the bones (osteomyelitic necrosis, abscess, tubercular caries, syphilis, rickets, osteomalacia, &c.).[1]

The consideration of spontaneous fractures will be omitted from the following work, which treats only of traumatic fractures of healthy bones. These we may divide into complicated and uncomplicated fractures (*i. e.* simple or subcutaneous ones), the complication consisting in a simultaneous wound of the skin and soft parts near the point of fracture. As a rule the fracture is thus itself exposed to the air, and the danger arises from infection from without; but a smaller

[1] Fractures of long bones from slight causes may occur in the subjects of tabes dorsalis and paraplegia, and may fairly be attributed to atrophy and rarefaction of the bones, due to the lesion of the nervous system. In tabes dorsalis fractures may occur before the onset of well-marked ataxia. They are most common towards the joint ends of the bones, are repaired with great difficulty, and if union does result it is attended with the formation of excessive callus (see Charcot's works, New Syd. Soc. Trans., and papers by Rivington and Hulke in 'Med.-Chir. Trans.,' 1893, pp. 171—196).—J. H.

wound of skin and soft parts, not reaching directly to the point of fracture, is in the same sense a complication. In these cases the antiseptic or aseptic treatment of wounds, according to the prevalent rules of surgery, is to be rigorously carried out, for then only can we count upon a good result in these cases of compound fracture which were formerly so dangerous. Apart from these precautions the treatment of these fractures is naturally based on the same principles as that of the subcutaneous ones, with the object of obtaining firm union of the broken bone with the least possible displacement or deformity. Experience shows that this task is much harder in cases of complicated fracture, and that sometimes we have to be content with a result which is far from perfect.

According to the degree of separation of the fragments at the point of fracture, we speak of a complete and of an incomplete form. To the latter belong *the fissure fracture*, which traverses the bone without altering its external form, and *the greenstick fracture*, which is most commonly seen in the bent tibiæ of rickety children, although it is also observed in other long bones of young adults, and in some of the flat ones.[1] In complete fractures the line of cleavage may have a varying direction, and we distinguish between transverse, oblique, longitudinal, and spiral fractures; if small fragments of bone are completely detached at the point of fracture, with or without their periosteal covering, we speak of a splintered fracture.

We may have also a multiple fracture of one and the same bone (at its upper and lower ends, and its middle), and finally simultaneous fractures of several bones (for instance, of the parallel bones of forearm and leg), or of bones widely separated from each other. It is of some interest to decide whether a fracture has occurred from direct or from indirect violence,—for instance, if the ulna is broken in parrying a severe blow we have a direct fracture; if a child falls on its hand and sustains a fracture of the clavicle or the lower end of the humerus the fracture is indirect. Since in the former

[1] As, for instance, in the remarkable depressions of the cranial vault sometimes met with in young children, which are almost invariably obliterated in time.

Fig. 1a. Fig. 1b. Fig. 2a. Fig. 2b

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PLATE I.

GREENSTICK FRACTURES.

Figs. 1 *a, b.*—Tibia and fibula of the left lower limb of a boy aged fourteen, who was caught between the cog-wheels of a threshing machine. The fibula is fractured about three fingers' breadth higher than the tibia; both bones are so bent at the point of fracture as to form a prominent angle forwards, a concavity backwards. The bending has brought about, in the first place, a gap on the convex side, and then produced a typical wedge of bone which is nearly detached so as to make a complete fracture; but it will be seen that the wedge is not wholly detached, at its lower end in the case of the tibia, at its upper in the case of the fibula.

Figs. 2 *a, b.*—Tibia and fibula from the body of a young adult in whom, by means of an osteoclast, a fracture was experimentally produced. It will be seen at once that the fracture is a greenstick one. In the case of the tibia it is a beautiful example of an oblique fracture.

contusion and hæmorrhage are present at the site of fracture, so the direct form, as a rule, must be held to be a more severe lesion than the indirect.

A point of interest to remember is the prevalence of different kinds of fracture at different ages. That the middle period of adult life furnishes the largest proportion of fractures is easily understood, since these patients are mostly engaged in hard work, and subject to accident.

In order to calculate this proportion correctly we have to consider the exact numbers of the population at different ages. We then find that fractures are most numerous between the ages of thirty and forty years (15·4 per cent.); further, in old people fractures are more numerous than in children; amongst the latter the minimum frequency is during the first ten years. The reason why fractures are so frequent in old age is partly the greater fragility of bone due to the senile atrophy, or diminution of the organic constituents.

In early life the presence of the layer of cartilage between the diaphysis and the epiphysis plays an important part, and we then meet with not so much true fracture as a traumatic separation of the epiphysis (as may occur spontaneously from inflammatory processes, particularly from acute osteomyelitis and from inherited syphilis).

In discussing the mechanism of the production of fractures we shall have to base our deductions upon the study alike of preparations obtained by accident, and of those derived from experiments on the dead subject. Most forms of fracture can be artificially produced without difficulty; and with the aid of this experimental evidence and by careful study of specimens of fracture, the shape of the fragments, &c., one can often deduce the kind of violence that has led to it, a point that may be of importance in forensic medicine. For example, greenstick fracture (see Plate I) is produced by bending a bone beyond the limit of its elasticity. The long hollow bones are thus broken in exactly the same way as a stick is bent and broken over one's knee. In actual life this fracture may arise in several ways,—for instance, by the passage of a weight over a bone having a hollow beneath it, by a violent strain on a bone which is fixed at one end, and by pressure in the longitudinal direction on a bone which

bends it, and if continued breaks it at its weakest and most curved point.

A greenstick fracture can also be produced by means of the osteoclast, or by simply bending a weak bone over the edge of the table.

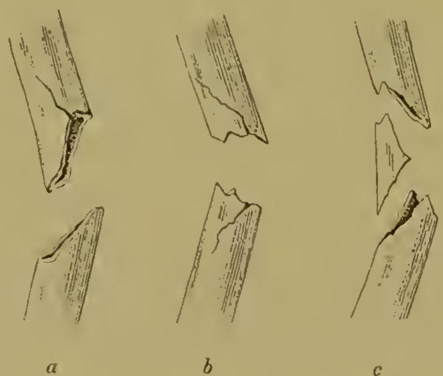

Fig. 1.—Different forms of characteristic greenstick fracture.
a. Oblique fracture.
b. Transverse fracture with fissures.
c. Oblique fracture with detachment of a wedge-shaped piece.

The form of a greenstick fracture is very characteristic and easily recognised in specimens, a fact which may be of importance from a medico-legal point of view. On the convex side of the curve there is a fissure, which as a rule is transformed into a slight gap by the pressure of a wedge of bone. The base of this wedge, which may or may not be wholly detached from the rest of the bone, is invariably placed on the concave side of the bent bone.

It is obvious, therefore, that by strong bending or inflection we have produced either a fissure or a true fracture (with detachment of a piece of bone), and that the fracture may be either transverse or oblique, according to the form or direction of the wedge.

It is possible perhaps to distinguish a variety of fracture from cracking or squeezing a long bone, which is produced by direct lateral pressure on the end of a bone which is fixed above, although no great bending occurs at the point where it gives way, *e. g.* the typical Pott's fracture of the fibula, from pressure exerted through the astragalus.

The torsion fracture (Plate II) is always caused by a

Fig. 1a

Fig. 1b

Fig. 2a

Fig. 2b

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PLATE II.

TORSION FRACTURES.

Figs. 1 *a*, *b*.—Torsion fracture of the upper half of the shaft of the femur from a woman aged eighty. The fracture arose from a twist of the body when her foot was fixed. The left femur is shown in its front aspect, and a beautiful spiral fracture displayed.

In fig. 1 *b* the two fragments are shown side by side (so to speak, unfolded from each other), so that the spiral form, the very oblique line of fracture, and a longitudinal split in the upper fragment may be observed.

Figs. 2 *a*, *b*.—Artificially produced torsion fracture. The spiral line can be well seen, and in fig. 2 *b* a rhombic fragment has been lifted aside. Two fissures running up the shaft are also shown.

Fig. 1a

Fig. 1b

Fig. 2

Fig. 3

PLATE III.

FORMS OF FRACTURE PRODUCED BY COMPRESSION, TEARING, OR CRUSHING.

Figs. 1 *a*, *b*.—Impacted fracture of the upper end of the tibia.

In fig. 1 *a* the front aspect is represented, and in fig. 1 *b* the vertical section of the bone. Both drawings explain themselves, and show especially what extreme pressure must have been exerted through the condyles of the femur on to the upper surface of the tibia, the shaft of which is driven into the separated fragments of the cancellous joint end.

Fig. 2.—A perfect example of the fracture from tearing, showing the lower end of the forearm of a young adult.[1] Both styloid processes are broken off in a jagged line. The detachment was produced by a machine accident to the hand, a violent dragging force being exerted through the lateral ligaments. The detachment of the styloid process of the ulna was incomplete.

Fig. 3.—Fracture from crushing the wrist end of the radius by machinery. The patient, a man aged fifty, slipped whilst attending to a steam engine, and had his left arm caught between the cylinders. Owing to the injury to the soft parts a primary amputation was required.

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[1] It is unfortunate there is no word in English which conveys the meaning of the German "Rissfraktur." It clearly expresses what may occur when a violent strain is produced on a particular part of a bone through the ligaments attached to it, and when the bone gives way rather than the ligament. Examples of it are numerous, *e.g.* fracture of the internal malleolus from forced eversion of the foot; fracture of the styloid process of the ulna with Colles's fracture of the radius; and fracture of the internal epicondyle of the humerus complicating dislocation of the elbow. In all these cases the fragment of bone is torn or dragged off by the force exerted through the attached ligament.—J. H.

twisting or rotatory force, and may arise when either extremity of the long bone is fixed. As a rule it is the end of the limb that is fixed, and the twisting force is exerted through the body, *e. g.* in a fall forwards when the foot and leg are fixed. On the dead subject a spiral fracture can be produced when the body is fixed and the limb violently twisted, especially if at the same time a sharp blow with a hammer is given over the part to be fractured. As a rule the bone breaks in a well-marked spiral line, and if the force is sufficient this spiral passes completely round the bone. Frequently two vertical lines of fracture join this spiral line, and in this way a rhombic fragment is more or less completely detached; its formation is characteristic of torsion fracture. Although the torsion fractures are always produced by indirect violence, yet they are of unfavourable prognosis, since the sharp fragments are apt to be displaced, to cause hæmorrhage, or even to perforate the skin.

Fractures from compression or squeezing (Plate III) are caused by external violence, which produces a sudden compression of a bone. This usually happens from the force being transmitted through a bone of greater resistance.

If the pressure is exerted through the shaft of a long bone the characteristic impacted fracture is produced at its joint end, in which the compact diaphysis is driven into the wider and more spongy region of the epiphysis. For examples of such compression fractures see Plate XXXIII, fig. 3 (upper end of the humerus), Plate LIV (impacted fracture of neck of femur into the great trochanter), Plate III, figs. 1 *a* and 1 *b*, Plate LXIII, figs. 3 *a* and 3 *b* (upper end of tibia and fractures of the os calcis from a fall on the foot).

To this category belongs also the detachment by pressure of small pieces of the articular borders of the bones.

Fracture from traction or dragging force is caused by a sudden pull exerted through muscles or ligaments, more rarely through an external force (*e. g.* the belt or strap of some machinery), at the same time that the neighbouring joint is forcibly bent or twisted.

Characteristic examples are found in the case of the patella and olecranon, fractures of the ankle, of the lower end of the radius, &c.

Fractures from crushing are illustrated in Plate III, fig. 3. In such a case a heavy weight may completely crush the bone into a number of irregular fragments (Plate IV). In fractures due to projectiles it may be noted that if a gun laden with shot is fired close to a limb the effect will be similar as regards splintering of the bone to that caused by a bullet. The modern weapons of warfare produce great splintering at distances, for instance, of less than half a mile. This effect in the war of 1870 led to the suspicion that the French used explosive bullets. The excessive splintering is explained either by the theory of hydrostatic pressure working through the bone, or more probably by the sudden and forcible displacement of small fragments of bone which exert their effect far beyond the part impinged upon. At very long distances, *e. g.* a mile, bullets produce circular apertures.

The Symptoms of a Recent Fracture.

The most characteristic feature of a fracture lies in the solution of continuity of the bone affected. 1. Abnormal mobility is the most important symptom, which, however, is wanting in the incomplete fractures and the fissured and impacted ones. For instance, the narrow shaft of a bone is driven into the expanded cancellous end, and so fixed that the two fragments again form a complete whole. In some other cases, such as fracture of the short bones and of the ribs, abnormal mobility is not always to be detected.

2. The presence or absence of crepitus depends chiefly on the existence of abnormal mobility. Other causes may lead to the absence of crepitus in fracture, as, for example, when the fractured ends are so displaced that they cannot be rubbed against each other, or when soft parts, such as portions of muscle or fascia, are interposed.

3. Another very important symptom of fracture is the visible or palpable deformity, which again is absent in fissured fractures and certain complete fractures in which there is no displacement. It is unnecessary to dwell on the importance of carefully comparing the bone of the oppo-

Fig. 1

Fig. 3a

Fig. 3b

Fig. 2

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PLATE IV.

GUNSHOT FRACTURES.

These fractures were experimentally produced by means of the modern German army rifle, loaded with the full amount of powder, and a bullet of 8 mm. diameter.

Fig. 1.—Fracture of the femur caused by bullet fired from a distance of 600 metres. The splintering is seen to be extravagant. The fragments have been put together again.

Fig. 2.—Fracture of the tibia produced by bullet fired from a distance of 50 metres. The central hole and the radiating lines of fracture are well seen.

Fig. 3.—Bullet aperture caused by rifle fired at the distance of 1500 metres. Soft parts, periosteum, and bone in the fresh state were cleanly bored through. Some fine fissures are shown. The aperture of exit at the back of the humerus was somewhat smaller than that of entrance, but was, like it, of circular form.

Fig 1

Fig 2

PLATE V.

DISPLACEMENT OF FRAGMENTS.

Figs. 1 and 2 are from the same preparation of an ununited fracture of the femur, and show axial rotation, overlapping and lateral displacement.

site side, and noting whether or not there is shortening. Various forms of displacement have been described, as follows:—lateral, angular, longitudinal, &c.

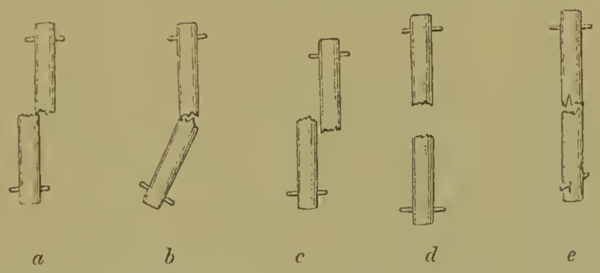

Fig. 2.—Diagrammatic representation of the various forms of displacement.
a. Lateral.
b. Axial.
c. Overlapping of fragments.
d. Vertical separation.
e. Axial rotation.

The causes of the deformity are of three kinds:—1st, the displacing force at the time of accident; 2nd, muscular contraction; and 3rd, the weight of the limb.

4. Effusion of blood in the adjoining soft parts is usually greatest in the case of direct fracture. Here, the crushing force and the fracture itself both help in producing it; if the fracture is close to a joint there is hæmarthrosis. The effusion of blood, if considerable, may render difficult the correct diagnosis of the fracture.

5. Pain in cases of fracture loses somewhat of its significance as a symptom from being purely subjective. In contrasting this pain with that attending a simple contusion, it is to be noted that the pain in fracture will be most intense at one localised spot, and much more widely felt in the case of a contusion. In fact, this symptom is of value only in indirect fractures, where the force has been applied at some distance from the point of fracture. At the same time, with impaction and fracture of bony prominences at the joint-ends, marked pain during certain movements of the joint, or during the contraction of muscles attached to them, may be a symptom of value.

6. Disturbance of function varies naturally with the kind and site of fracture; thus, for instance, it may be very slight

in some cases. Patients with recent impacted fracture of the neck of the femur, or fracture of the fibula alone, may be able to walk, and patients with recent fracture of the ulna may be able to use the arm.

The Examination of Cases of Fracture.

I strongly recommend the more frequent use of anæsthetics in suspected cases of fracture, for without their aid it is often impossible to make a correct diagnosis. Particularly difficult and responsible is the examination of patients who are unconscious after an accident; here it must especially be remembered that many fractures or that both fractures and dislocations may be present at the same time.[1] The importance of exact measurements and comparison with the sound side must also be emphasised. In the examination of cases where the fracture has occurred at some distance of time, and the reason for or degree of incapacity for work has to be estimated, the greatest care must be taken in coming to a conclusion. As a rule some deformity will be found as the cause of persistent loss of function, but we have also to think of troublesome œdema, excessive formation of callus, persistent mobility (delayed union), stiffness of the adjacent joint, injury to a neighbouring nerve-trunk, atrophy of the

[1] For example, a man fractured one forearm in a fall. This was well treated, but the fact that he had dislocated the humerus on the same side was overlooked for six weeks. At the end of this time, after several attempts, the bone was reduced, but an axillary aneurism followed, which was successfully treated by ligature of the subclavian artery (Rushton Parker, 'Lancet,' April 18th, 1885).

A young man sustained a compound fracture of the skull which necessitated trephining. Whilst in the hospital his temperature continued to be raised, and a swelling formed over the left clavicle. This proved to be an abscess which had developed around a simple fracture of the clavicle, which had been overlooked for a fortnight chiefly on account of the gravity of his head injury.

A man sustained a compound fracture of his right elbow. He was treated with success for this in hospital, but complained persistently of pain down the arm. At the end of a month this was discovered to be due to a dislocation (subcoracoid) in the shoulder above, which was fortunately reduced.—J. H.

Fig. 1.

Fig. 2.

PLATE VI.

Fig. 1.—Fracture of the left humerus. Skiagraph taken from the back.

Fig. 2.—Skiagraph of a fracture of both bones of the forearm in a young subject.

Fig. 1.

Fig. 2.

PLATE VII.

Fig. 1.—Skiagraph of a fractured patella, the two fragments of which are widely displaced.

Fig. 2.—Skiagraph of a fracture of both bones of the forearm in a young subject, taken from the same case as fig. 1.

muscles, &c., as possible causes of the patient's trouble.[1] Frequently the external signs do not at all correspond with the extent of crushing or splintering of the bones beneath,—for example, when the foot is run over and the tarsus completely crushed whilst the skin is unbroken. A mere fissure fracture may bo almost impossible to diagnose. The Röntgen rays are frequently of much value in the diagnosis of fractures and in deciding whether they have been correctly put up, and the surgeon must reckon upon his patients testing the efficiency of his treatment by skiagraphy.

Sequence of Events in the Healing of Fractures.

After a bone has been broken swelling of the soft parts around soon follows, due in part to the effusion of blood, in part to infiltration of the tissues. The more severe the injury the greater will be the swelling, and the amount of the latter will also be determined by the amount of blood extravasated and the length of time that has elapsed before the fracture is put up. These circumstances naturally have some effect upon the organism.

At the site of fracture the bone marrow and other soft tissues are crushed up, and from the absorption of these, perhaps still more from the influence of the blood-ferments, which are also absorbed from the extravasation, we find that slight febrile disturbance (rise of temperature, &c.) is produced. That blood-ferment, when absorbed, is capable of producing fever has been proved experimentally (Angerer).

Larger or smaller quantities of fat reach the circulation from the crushed bone marrow, and are partly excreted by

[1] There are some obscure but very important cases of what is apparently a peripheral neuritis affecting one or more nerves of a limb, and set up by a fracture of a long bone as by other forms of injury. In this way the limb may become comparatively or wholly useless as the result of paralysis and atrophy of the muscles, persistent neuralgia, trophic changes in the joints, &c. Thus in one case spreading neuritis of the whole brachial plexus appeared to be due, or at any rate commenced soon after, a fracture of the olecranon, which united by fibrous tissue. In this case the ulnar nerve seemed to be the first one affected, and the neuritis to have spread up along it to the other cords of the plexus. Such cases must not be forgotten in considering the possible remote results of a fracture.—J. H.

the kidneys. For this reason, in many cases, soon after the occurrence of fracture, fatty matter can be detected in the patient's urine, together sometimes with albumen and casts.

In the neighbourhood of the fracture itself the swelling due to the blood effusion and a form of inflammatory œdema may last several days, but in cases properly treated they are already on the decrease at the end of a week. The extravasation of blood then begins to show by its well-known discoloration, and the stretching of the skin relaxes. When there has been great swelling one often notices bullæ containing serum, which do not interfere in any way with the progress of the case provided correct treatment is followed; they indicate, however, the necessity for disinfection of the skin and the use of an aseptic dressing. Around the site of fracture, as the swelling goes down, a rounded swelling of almost cartilaginous hardness will be noticed, which gradually shades off into the normal bone.

Fig. 3.—Formation of callus round a recent fracture of the rib without displacement.

It is a remarkable fact that this process is the rule,—alike in new-born children and in extreme old age, under normal conditions every fracture unites by bone.

The formation of this callus is almost entirely due to the periosteum, which, owing to its being torn irregularly and irritated by small fragments of bone, is stimulated into a form of periostitis ossificans. The medulla is not wholly passive, but shows a slight tendency to form callus, so that where the two ends are but little displaced we may notice, 1st, a ring of mortar-like external callus; 2nd, the internal or medullary callus; 3rd, connecting these two a very slight intermediate callus developed from the bone itself. The formation of callus is naturally much more copious when the fragments are greatly displaced, and it is least in the case of fractures of children when the periosteum has been untorn. In cases of complicated fracture there may be sometimes necrosis of one or both ends of the fragments. As in

Fig. 3a

Fig. 3b

Fig. 3c

Fig. 1

Fig. 2

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PLATE VIII.

FORMATION OF CALLUS.

Fig. 1.—Vertical section of a humerus with united fracture. Slight displacement. The callus is moderate in amount, and is now formed of compact bone. The medullary canal is open, and is only narrowed by a few layers of spongy bone.

Fig. 2.—Vertical section of a tibia, with a fracture united at an angle. The former compact circumference of bone has become more cancellous, and the medullary cavity is interrupted.

Figs. 3 *a, b, c.*—Specimens from a case of severe compound fracture of the femur. Owing to septic inflammation of the wound necrosis of a complete ring of bone followed, and amputation was done, since there appeared to be no probability of union.

Fig. 3 *a* shows the lower fragment with the main sequestrum.

Fig. 3 *b* shows the upper fragment in vertical section, so that the new periosteal bone and that within the medullary cavity are displayed.

Fig. 3 *c* is the sequestrum detached from the upper fragment with its stalactite-like projections.

necrosis due to osteomyelitis, the dead part is gradually thrown off by a process of rarefying osteitis, the time required for the separation varying from two to six months, according to the age of the patient, &c. Meanwhile new bone has been produced from both sides by means of ossifying periostitis so freely that after removal of the sequestrum the union of the fracture will be probably quite firm.

Whereas formerly the production of callus was separated into provisional or definitive, we can now only use these terms as implying that after the union of a fracture (in the ordinary sense of the words), during the ensuing months and even years, certain further changes gradually occur which alter the anatomical conditions at the site of the fracture. In other words, the abundant and spongy callus becomes more scanty and firmer, gradually taking on the character of compact bone. Absorption takes place of all that part of the callus which is not required in the mechanical sense. The medullary canal may possibly be restored. These gradual changes are illustrated in Plate VIII.

On Certain Severe Complications of Fractures.

1. *Fat embolism* has already been alluded to. Whilst the absorption of small quantities of fat is of no importance, that

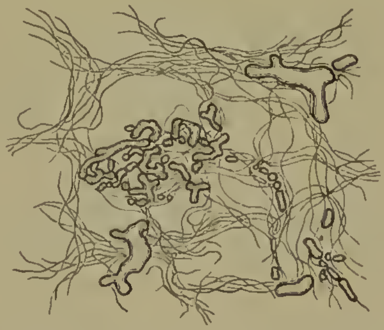

Fig. 4.—Fat embolism in the lung. Fresh preparation prepared with sodium hydrate. The fat is shown within the capillaries and in isolated drops.

of larger amounts may be very dangerous and even fatal. The fat is set free from the medullary canal, and also from

the damaged adipose tissue round the bone. Thus fat in a liquid condition, at the temperature of the body, can be taken directly into the torn veins of the bone, and so get access into the general circulation,—in part also may be absorbed by the lymphatics. It is usually arrested as fat emboli in the capillaries of the lungs; if it passes through these it may form emboli in the arteries of the various organs,—as, for instance, the central nervous system. The treatment consists in stimulating the heart in order to favour elimination of the fat through the kidneys.

2. Thrombosis of veins and subsequent embolism is a rare but very dangerous complication after simple fractures. Cases have occurred in which during the healing of the fracture sudden symptoms of asphyxia have developed and caused death. At the post-mortem examination embolism of the pulmonary arteries has been found, consecutive to venous thrombosis in the neighbourhood of the fracture.

In other cases which recovered, the diagnosis of embolism of the pulmonary arteries could be made from the clinical symptoms.

Thrombosis of the veins in the neighbourhood of a fracture, often causes œdema of the limb affected. This complication is most frequently seen in the lower extremity (usually within three weeks from the date of fracture), sometimes in comparatively slight fractures,—as, for instance, in a recent case of fractured patella.

3. Wounds of the main blood-vessels are a very rare complication. They have been most often observed in the case of the anterior and posterior tibial arteries; they may lead to profuse hæmorrhage, to aneurism,[1] or to gangrene of the limb.

4. Damage to nerve-trunks may occur in several ways, of which examples are met with especially in the case of the musculo-spiral and external popliteal nerves. They may be injured directly by the force which produces the fracture,

[1] Perhaps the most remarkable case of this on record is that figured by Sir Charles Bell ('Observations on Injuries of the Spine and Thigh-bone,' pl. iv, fig. 3). A lad had separated his lower femoral epiphysis, which united with the edge of the diaphysis, projecting backwards. It was not till over twenty years later that the erosion of the artery by this edge of bone led to an aneurism requiring amputation.—J. H.

by damage from a displaced fragment, and finally by implication in the callus. Operative interference in the two latter cases has frequently been followed by success

5. Delayed formation of callus. Whereas frequently the callus forms in excess, and occasionally true tumours of callus (osteoma, enchondroma) develop, we sometimes observe an abnormal retardation of its formation. It is difficult to fix on the cause for this.

FIG. 5.

FIG. 6.

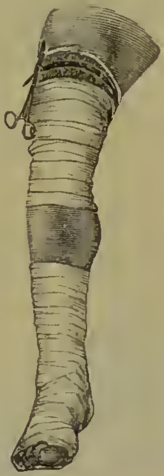

Fig. 5 —Musculo-spiral nerve thickened where it ran through callus of a united fracture of the humerus. The nerve was freed by chiselling away the bone, and the paralysis cured.

Fig. 6 —Method of producing venous hyperæmia at the seat of a fracture. An elastic tourniquet is drawn tightly over a linen band, and secured by Spencer Wells forceps. The limb is, moreover, so bandaged that the effect of the hyperæmia is localised to the region of the fracture.

It is of practical importance to note that with lapse of time and appropriate treatment consolidation of the fracture is almost always arrived at.

Amongst the measures to be taken are—(1) generous diet, &c.; (2) allowing the patient to be up and have the fractured limb dependent in suitable splints; (3) the production of hyperæmia at the site of fracture by means of elastic bands or bandages above and below (Fig. 6); (4) still more active treatment in the form of rubbing the fractured ends

together, and introducing pegs into the fractured ends in order to produce stronger reaction.

6. By pseudarthrosis is understood a new false joint at the site of fracture. True pseudarthrosis must imply the forma-

Fig. 7.—Pseudarthrosis with fibrous union of the ulna (after Bruns).

tion of a joint cavity and capsular membrane. Now-a-days this complication can usually be prevented or cured by operation.

The formation of a pseudarthrosis may depend upon general or local causes: of the former, syphilis and general

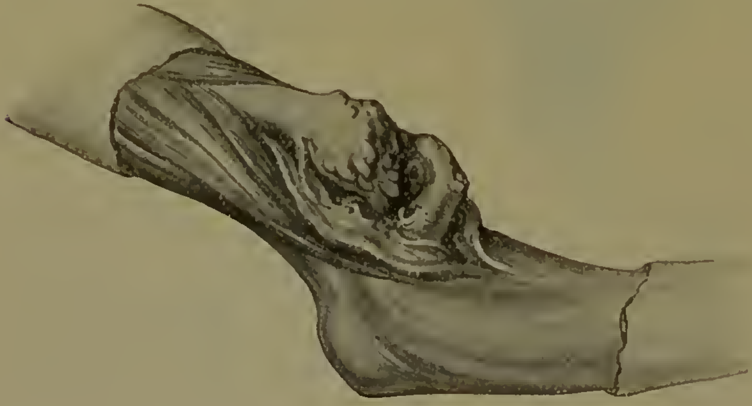

Fig. 8.—False joint after fracture of the humerus. Of the two ends of the bone one is somewhat knobby; the other forms a kind of a cup. The articulation is surrounded by a true capsule, presenting a villous surface.

debility are the chief; of the latter, for instance, the callus may be deficient, owing, perhaps, to the fracture having been comminuted and compound, and much bone having been lost. In other cases, even with normal formation of callus, a false joint may result from interposition of soft parts, or wide separation of the fragments. The interposition of the soft

parts, and especially of muscle bands (*e.g.* in the case of fracture of the femur or humerus), is an absolute hindrance to bony union. The diagnosis of this complication in a

Fig. 9.—Dry specimen of a complete false joint. From the same specimen as Fig. 8, only macerated. The medullary cavity was quite closed at either end.

recent fracture can be made occasionally by the marked movement of the fragments when the implicated muscle contracts, or perhaps better by the absence of crepitus. In such cases energetic attempts to dislodge the interposed muscle, &c., if necessary by operative interference, are strongly to be recommended. Marked over-riding of the fragments is especially seen in the case of the humerus and femur; and here, although much callus be formed, no real union may be present. It is hardly necessary to point out that imperfect immobilisation is here of considerable importance.

In the treatment of pseudarthrosis operative removal of the interposed tissues, resection of the ends of the fragments, and suture by silver wire may lead to a cure. Transplantation of bone may also be useful.

7. Suppuration at the site of a simple fracture (*i. e.* in the surrounding extravasation of blood) may occur without the smallest wound of the skin, or without the presence of any point of infection (furuncle, &c.).

8. Delirium tremens is a serious complication of fractures in alcoholic subjects, and should it occur it may be necessary to fix the fracture in plaster of Paris strengthened with steel bands. The patient, who is rendered by his delirium unconscious of pain, should be carefully watched lest he get out of bed, and narcotics should be used with great care. As a

Fig. 10.—Old pseudarthrosis in the left forearm resulting from severe fracture and loss of bone in early life.

The patient, a man aged forty-four, broke, when he was a child of eight, his left forearm in several places as the result of a fall. Pieces of bone came away, and it was only after nine months' treatment that healing resulted, though the arm remained almost useless. At the present time there is ankylosis in the left elbow, and the fingers are fixed in a flexed position. The left forearm is 11 cm. (4½ inches) shorter than the right. There is a false joint at the junction of middle and lower thirds. In the peripheral part the ulna is wholly wanting, the radius alone remaining. If not supported it falls with the hand in a helpless manner. The patient uses a kind of splint devised by himself, and manages then to move the thumb slightly towards the ankylosed fingers. Depressed scars are present at the site of fracture and at the elbow. Probably the fracture was compound from the first, wide-spread suppuration followed, and the lower end of the ulna had to be removed. The joints of the hand and the tendon sheaths have all stiffened.

prophylactic measure the alcohol to which the patient is accustomed should not be wholly left off, and care taken that he does not pass a sleepless night.[1]

[1] As soon as the symptoms which foreshadow an attack of delirium tremens (tremor of hands or tongue, increased pulse-rate, restlessness, purposeless movement of the hands, air of suspicion, or commencing delusions) are observed, prompt measures should be taken to avert the attack. If the patient is not already taking beer or stout he should be given a moderate quantity, together with a sedative such as bromide of potassium grs. xx to grs. xxx, and chloral hydrate grs. x to grs. xv, every four hours. In addition he should be induced to drink fluids, such as water, freely. If the bromide is alone relied on it may be given in still larger doses.—J. H.

Prognosis of Fractures.

Prognosis of simple fractures is very favourable except in very old or feeble patients, and unless the complications mentioned above supervene. With fracture of the lower limbs in old people a considerable proportion die of hypostatic pneumonia. As to the effect upon the usefulness for work of certain special fractures, we have only lately obtained numerical information. It was, of course, known that consolidation followed sooner in healthy individuals, after thorough overcoming of the displacement. One knew also that the prognosis was more unfavourable in the case of spiral fractures (on account of extensive damage to the medullary cavity), and of direct fractures on account of simultaneous damage to the soft parts. It was also known that long-continued rest of an extremity led to atrophy of the muscles and to stiffness, with other changes in the immobilised joints, but more exact knowledge has only lately been obtained on the subject.

A patient with a fracture may be said to be cured only when he is again able to work; fractures cause only too often persistent incapacity for work. Out of 121 cases of fracture of the shaft of the femur, 34 per cent. were completely cured in this sense, whilst 66 per cent. remained permanently damaged. The average duration of time before a cure was obtained was 13½ months. Out of 19 cases of fractured neck of femur 12 per cent. died, 12 per cent. were cured, and 76 per cent. sustained permanent damage. Out of 148 cases of fracture of the leg bones, 78 per cent. were completely cured; out of 30 cases of fracture of the humerus, 72 per cent.; out of 67 cases of fracture of the forearm, 87 per cent. were cured. The causes of these unfavourable results and of the long period of time required for the treatment are to be sought in the following: displacement of the fragments, stiffness of the neighbouring joints, sometimes hypertrophy of the callus, delayed union, pressure on nerves, persistent pain, and œdema of the limb. These facts emphasise the teaching that the details of treatment are all-important in the ultimate result. Not only in the case of

compound fractures, but also in that of simple ones, the fate of the patient rests in the hands of the surgeon.

Treatment of Fractures.

(*Note.*—Some observations on the importance of obtaining exact reduction, &c., have been omitted, as being too rudimentary to require translation.)

There is real danger in applying plaster-of-Paris bandages around a limb recently fractured, and many disasters have occurred from disregarding this rule. The swelling of the tissues under the plaster, and the contraction of the latter, may lead to complete anæmia of the muscles, and their permanent shortening and atrophy (see Fig. 12); or to gangrene of the limb from complete stoppage of the arterial flow (see Fig. 11). In the former case, whilst the response

Fig. 11.—Gangrene of the leg following the treatment of a simple fracture by a tight plaster-of-Paris bandage, which was applied immediately after the accident, and only removed twenty-three days later, in spite of the toes having been at first purple, then black, and the part extremely painful. At the end of fourteen months the gangrenous end had not yet separated.

to direct galvanic stimulus of the muscles is more or less completely lost, that of the nerve-trunks may be retained intact.

In the treatment of fractures by splints, those made of bent metal and the moulded plaster-of-Paris ones are strongly to be recommended.

In the use of all forms of apparatus, it must never be forgotten that pressure is not to be applied directly over the

FIG. 12.

FIG. 13.

FIG. 14.

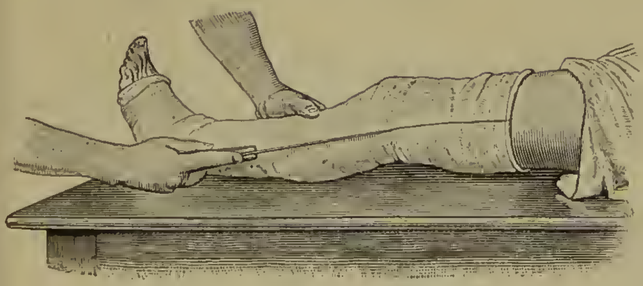

FIG. 15.

Fig. 12.—Paralysis and contraction of the forearm muscles in a lad aged seventeen, which had resulted from the application of a tight plaster-of-Paris bandage, ten years previously, over a fracture of the lower end of the humerus.

Fig. 13.—Splints made out of bent metal, applied to a fracture of the lower end of the humerus.

Fig. 14.—Plaster-of-Paris splint being cut open along the side.

Fig. 15.—Saw for cutting open plaster-of-Paris splints.

Fig. 16.—Plaster-of-Paris splints, the edges of which are trimmed with sticking-plaster.

fracture, since this method of attempting to reduce a displacement is unsatisfactory and dangerous. Treatment by weight extension is not only useful in the case of fractures

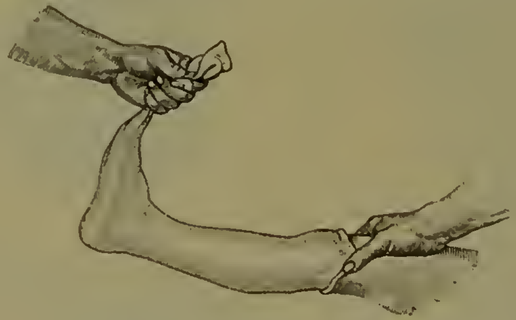

Fig. 17.—Application of plaster-of-Paris splints to the leg and foot.

of the femur, but also in some examples of fracture of the humerus. For this purpose a combination of india rubber bands and strapping is often of use (see Fig. 18).

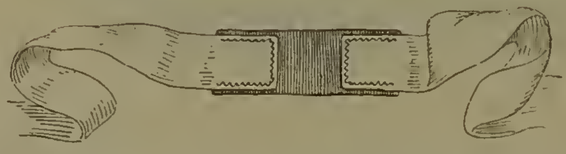

Fig. 18.—India-rubber band with strapping sewn to either end, used in obtaining elastic traction.

Certain methods of treatment of particular fractures are adapted for use in specially skilled hands, but not in my

opinion for general practice. It cannot be doubted that the open method of suture of a fractured patella gives remarkable results in the hands of skilled surgeons; and again, for example, the treatment of Colles's fracture without the use of splints at all.[1]

When the opportunity is afforded by the readjustment of splints, massage and passive movement should be employed to the imprisoned joints, and after the fracture has united they are both of importance, together with warm baths and careful bandaging and the use of mechanical apparatus. We have to specially notice the treatment of fractures into the joints, involving extravasation of blood into the latter. The problem to be solved includes securing firm union of the fracture with a moveable joint; in such cases frequent change of dressings every two to three days during the first fortnight, and after that daily, is to be recommended.

In order to obtain absorption of the blood, if aspiration is not employed, careful bandaging over the joint and massage and passive movement on the occasion of each change of dressing, the fixation of the limb in different positions, and the early use of active movement and mechanical apparatus, are to be recommended. The carrying out of such treatment involves great patience on the part of the surgeon, but it is extremely satisfactory in such a case to obtain good movement of the joint after the fracture is united.[2]

A few words must be said about badly united fractures. In spite of every care, it may befall any surgeon to be disappointed with the results of his treatment, and the stupidity

[1] To dispense with splints and to employ massage from an early date in cases of various fractures, such as those of the fibula, is an apparently novel suggestion, which Lucas Championnière and others have brought forward. But the practice has been in vogue amongst the Hottentots and other African races for very long as the routine method of treating fractures.

[2] In the case of a fracture through a joint (*e. g.* the elbow or knee) the best plan is to fix the fragments in as good position as possible, and keep them at rest until sufficient time has elapsed for union to take place, and then for the first time to employ passive motion. If the latter is carried out at frequent intervals during the first fortnight, as suggested above, the process will be very painful, and may lead to non-union or to excessive callus. In these cases passive motion begun too early simply defeats its own object.—J. H.

or carelessness of some patients may account for some cases of fracture united with deformity which come to us for further treatment. In these cases it is best without further loss of time to re-fracture the bone, either by means of an osteoclast or an osteotome, and to obtain better position by manual pressure, weight extension, &c.

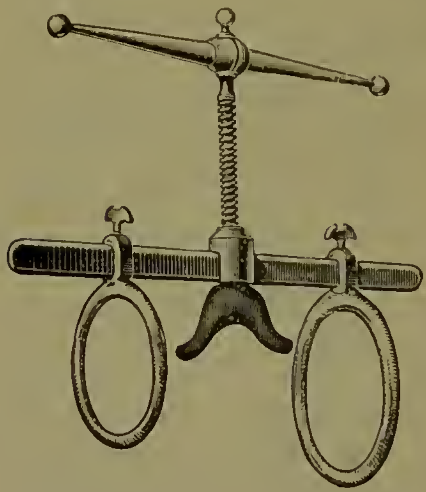

Fig. 19.—Rizzoli's osteoclast.

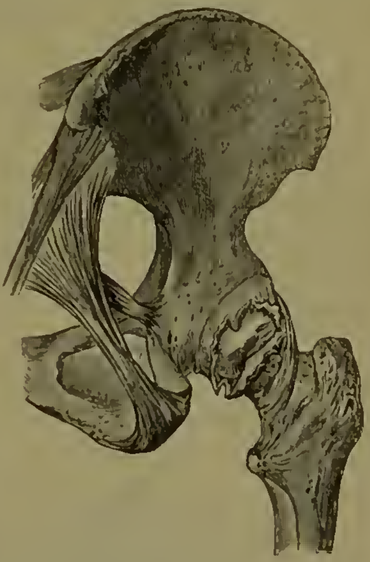

Fig. 20.—Intra-capsular fracture of the neck of the femur, resulting in non-union. Specimen seen from behind.

On Dislocations.

(The greater part of this section has been omitted, on account of its being only rudimentary.)

After reduction of a dislocation and appropriate fixation of the part the extravasation and slight synovitis due to the injury disappear in from eight to fourteen days. As soon as possible, even before this time has elapsed, massage and passive motion should be begun, to be abandoned for a time if pain and signs of inflammation of the joint come on. After three weeks have elapsed it is usually safe to allow active motion.[1]

[1] It is desirable to exercise much caution with regard to allowing active motion from the fear of a re-dislocation. This holds true particularly of

shallow or ill-protected joints, such as the shoulder. The rent in the capsule is repaired but slowly, and even many weeks after the reduction it is possible, in a sudden movement whereby the arm is raised and abducted, for the humeral head to again leave its socket. I have had to give evidence in a law case where the re-dislocation had occurred at least three months after the first accident. Heavy damages were claimed by the plaintiff, who had been specially warned of the risk from abducting the arm vigorously. If a re-dislocation once occurs it may be expected to recur again and again.

Do true dislocations occur iu infancy and early childhood?

Although separation of the epiphyses to a considerable extent takes the place in very early life of true dislocation, there cannot be the slightest doubt that genuine cases of the latter may occur even at birth.

It was formerly suspected that congenital dislocation of the hip was due often to violent manipulation during delivery; but this theory has nothing to support it, and is most improbable, seeing how often the dislocation is symmetrical. During parturition the arms of the infant are much more likely to be damaged than the lower limbs, and cases of fracture of the clavicle, dislocation of the humerus, and fracture of the latter bone are not very infrequent from this cause. Separation of the upper epiphysis during labour may also occur. If overlooked, and not correctly treated, these injuries may produce the most serious results on the arm affected, and *it is very easy to overlook them in young fat infants.*

Cases of true traumatic dislocation in young children affecting almost any one of the chief joints in the body could readily be adduced. Thus Powdrell reports a case of thyroid dislocation of the hip occurring in an infant aged six months, and readily reduced by manipulation.

By far the commonest true dislocation in young children is the subluxation of the radial head, which, unlike all other dislocations, is confined to children under five years of age.—J. H.

CHAPTER II.

FRACTURES OF THE CRANIUM, SPINE, ETC.

In considering the subject of fractures of the skull, both vault and base, it is of interest to note the elasticity of the bone, for it is only after a force has exceeded the limits of this elasticity that a fracture can take place. It is well known that the inner table is usually more widely splintered than the outer one, and an attempt has been made to explain this by a greater fragility of the inner table. It is now known that the fact is to be explained by simple mechanical considerations, and that when the force acts from within (*e. g.* by a bullet passing through the skull), the outer table in its turn will be more widely fractured than the inner one. The blow causes a bending inwards of the table first compressed, which bending leads to a dissemination of the force

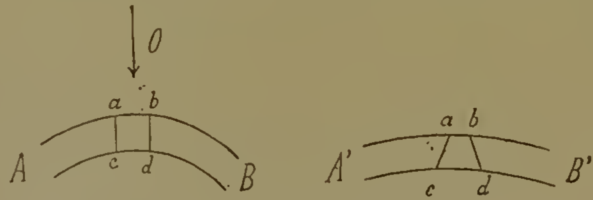

Fig. 21.—The segment of the skull *A B* has been struck at the points *a b*. Owing to its elasticity it has taken the form *A' B'*. Hence the particles of bone at *a b* have been squeezed together, whilst the corresponding portion of internal table at *c d* has been stretched and the particles torn asunder. The result will be understood from comparing the quadrilateral *a b c d* in the two figures.

and wide-spread splintering. Plate IX and Fig. 21 explain the preceding statement.

Fig.1

Fig 2

Fig. 3b

Fig.3 c

Fig.3a

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PLATE IX.

FRACTURES OF THE VAULT OF THE SKULL.

Fig. 1.—Bullet perforations made from without and from within, as indicated by the arrows. It will be seen that the aperture of entrance is circular and much smaller than the aperture of exit, which latter is irregular in shape.

Fig. 2.—Fracture produced by a bullet fired with so little force as not to perforate the skull. It will be seen that the outer table is merely slightly depressed, but that the inner table is widely splintered.

Figs. 3 *a*, *b*, *c*.—An old depressed fracture of the skull. Here again it will be noted that the inner table is the most widely broken.

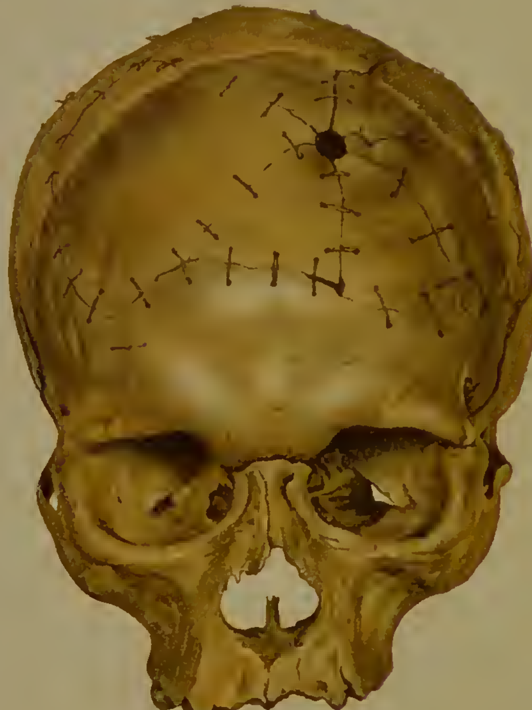

Fig. 1

Fig. 2

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PLATE X.

BULLET FRACTURES OF THE SKULL.

Figs. 1 and 2 show the front and back aspect of a skull traversed by a bullet fired from an ordinary German infantry rifle at a distance of 200 yards. The aperture of entrance is much smaller and more regular than that of exit. There are wide-spread radiating lines of fracture around both.

Fig. 1b

Fig. 1a

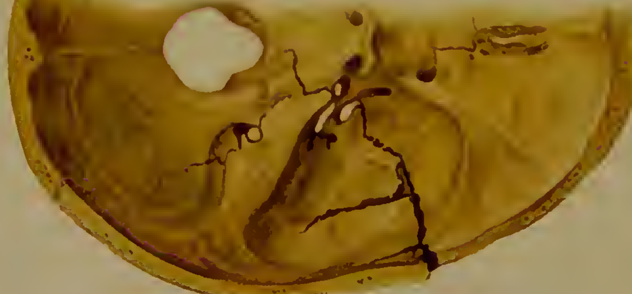

Fig. 1c

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PLATE XI.

These figures are somewhat diagrammatic, being founded on a museum specimen, and on a patient who recovered from the accident. In the latter case he had been struck by a brick on the left temporal region and the vertex of the head, sustaining a fracture complicated by depression of the bone, and a gap which gaped widely, together with effusion of blood between the dura mater and the bone, from rupture of the middle meningeal artery. The blood-clot is well shown in fig. 1 *a*.

Fig. 1 *b* shows the fracture running up along the coronal suture, but ending as a fissure which bends off into the parietal bone.

It will be understood that it is possible to produce an isolated fissure of the internal table by means of some blunt instrument, &c., without any fracture of the outer table, and the converse statement may even hold true with regard to the outer table. On the other hand, if the force be exerted by a sharp instrument the outer table alone may be depressed or fractured; this has been repeatedly observed in the case of sabre wounds and the like.

More common than the fractures of the internal table alone are those in which the outer table sustains some slight lesion (fissure or groove) whilst the inner table is widely splintered, and the splinters project inwards towards the cavity of the skull, like the rafters of a roof. Sometimes a breach of continuity in the vault of the skull occurs in the

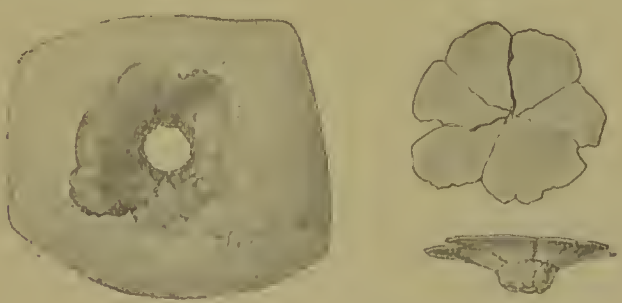

Fig. 22.—Experimental bullet perforation from within of vault of the skull. It will be seen that the piece of bone driven outwards has somewhat the shape of a mushroom when looked at from the side, whilst viewed from above it has the appearance of a rosette. I have several times observed this appearance.

line of a natural suture.[1] *The treatment* of depressed fracture of the skull with wound of the soft parts involves careful disinfection of the latter, which will be best done by cutting

[1] *The venous sinuses in relation to fracture of the skull.*—Both the lateral and superior longitudinal sinuses may give rise to very serious hæmorrhage from rupture due to fracture, or from a wound during the operation of trephining. It is quite impossible to stop the bleeding by ligature, and the only treatment consists in plugging with antiseptic gauze and direct pressure. Improbable though it may seem, it is yet possible for a man to recover after having one lateral sinus freely opened by a sabre wound on the field of battle (see Specimen 868, Museum Royal College of Surgeons).—J. H.

away the damaged and infected edges of the scalp wound with scalpel and scissors: after this the depression must be elevated; this usually implies trephining at the edge of the fracture. It is important to remove all sharp fragments of bone, especially since septic particles from outside (*e. g.* hairs) are often driven in between them. This fact I have repeatedly observed in the macerated preparations at Leipzig and Munich, and it will be understood that the force at the time of the accident may wedge these hairs firmly between the fragments, and thus lead to meningitis by septic infection.

If the fracture is subcutaneous the indications for operation are much less clear. We know now, contrary to what was lately taught, that a depression producing a considerable diminution in the capacity of the skull may have little or no bad effect on the brain; nevertheless such a depression may later on exceptionally lead to such symptoms as Jacksonian epilepsy, for which an operation may become necessary.[1]

[1] *Hernia cerebri.*—Hernia cerebri is a most important complication of compound fractures of the skull, but one which has of late become much rarer owing to surgical operations being more frequent on depressed fractures, and to aseptic precautions (see an important review of the subject by Lawford Knaggs, 'Med.-Chir. Trans.,' 1897, pp. 249—302, with abstracts of over a hundred cases; three fourths of these were due to compound fracture). The following deductions may be drawn:

1. Hernia cerebri always means inflammatory softening of the brain to a varying depth, but by no means always implies an abscess within the skull.

2. Its chief dangers lie in the development of cerebral abscess and of general meningitis, the latter often the result of injudicious surgical interference.

3. The symptoms due to cerebral abscess (coma, paralysis, &c.) may be of extremely rapid onset, and cause death in a few hours. Prompt evacuation by trocar or tenotome and drainage is demanded.

4. The prognosis of recovery in cases of hernia cerebri treated by asepsis, but otherwise left to nature, is probably 50 per cent.

5. In its treatment pressure is useless and dangerous, and apart from the use of antiseptics other surgical treatment is hardly ever required unless an abscess requires evacuation.

6. In all operations on compound fractures of the skull, &c., the surgeon should endeavour by strict asepsis, the suture of divided dura mater, and the replacement of viable fragments of bone from which all sharp angles have been cut off, to prevent the later development of hernia cerebri.—J. H.

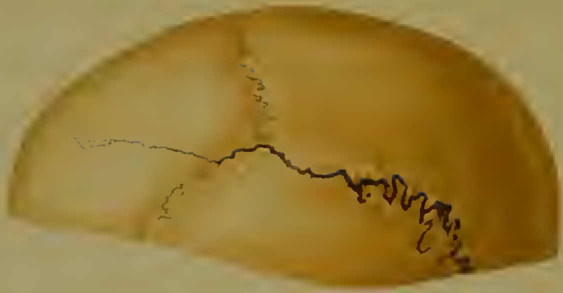

Fig. 1

Fig. 2

Fig. 3

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PLATE XII.

VARIOUS FRACTURES OF THE VAULT AND BASE OF THE SKULL.

Fig. 1.—Vault, with a fissure traversing the frontal bone, and a starting of the suture between the temporal and parietal bone.

Fig. 2.—Fracture of the base of the skull from pressure against the spine due to a fall on the head. The fracture is all round the foramen magnum, and some pieces of bone have been lost in maceration.

Fig. 3.—Antero-posterior section through the base at the level of the temporo-maxillary joint (normal). The drawing shows the relations between the condyle of the jaw and the thin portion of bone above it.

Fractures of the Base of the Skull.

It is easy to understand that fractures of the base of the skull chiefly follow indirect violence; a direct lesion of the base from ordinary violence is only possible at the roof of the orbit and the nose, but gunshot injuries may naturally implicate the base of the skull at any spot. Formerly it was the custom to invoke the theory of *contre-coup* to explain fractures of the base, but with advancing knowledge this theory has receded more and more into the background. Careful study of fractures of the base and many experiments on the dead subject have shown that fractures of the base from indirect violence present a certain regularity of form, and can be explained in a particular way. This holds good naturally for those cases which have resulted from a moderate degree of violence; where a tremendous crushing force has been applied there can be no regularity in the lines of fracture. The following points are of importance in explaining the form and direction of fractures of the base. First, the base may be considered as the weakest part of the skull. This is only true to a certain extent, since along with the thin and almost translucent areas, which, moreover, present large openings for nerves and vessels, we find here strong parts of bone which to a certain extent act as buttresses. As such we have to notice the petrous bone on either side, and the ridges bordering the sphenoidal wings. These pillars converge towards the pituitary region and the front edge of the posterior fossa. Observation shows that fractures of the base pass transversely by preference between these pillars. Nevertheless it is common enough for the petrous bone to be itself involved. Second, by far the greater part of fractures of the base commence above in the vault, *i. e.* from the point where the force is applied, and run thence by the shortest route to the base; and since the force is most commonly applied to the top of the head, the fracture will usually implicate the middle fossa. Third, a certain proportion of fractures of the base arise in an indirect manner, owing to one or other of the face bones or of the vertebræ being driven into the base. This may, for instance, occur

when a patient falls on his feet or in a sitting posture; the fractures then radiate from the foramen magnum, and are very characteristic in appearance. They can be produced by experiment on the dead body. In a similar manner to the action of the vertebræ, the bones of the face may be driven inwards so as to produce fracture of the base (see Plate XIII). On Plate XII, fig. 3, it is seen that just above the condyle of the jaw the bone is very thin, and occasionally it is fractured by the jaw being driven upwards; but this is rare on account of the jaw itself usually breaking, and of the bone immediately round this thin spot being so strong as to protect it. Fourth, in very rare cases a fracture of the base is produced by extreme compression of the skull. The fracture then will be either longitudinal or transverse to the long axis of the skull according to the direction of the compressing force. In such cases the lines of fracture are not always the same, but taken as a whole are fairly characteristic (see Plate XIV). Isolated fractures of the orbital roof, and more rarely of other parts of the base, cannot readily be explained; but the influence of hydrostatic pressure may be invoked, and it is not to be wondered at that when severe pressure is exerted on the whole skull the thinnest part of it may crack.

The symptoms of a fracture of the base naturally vary according to the extent and position of the fracture. Of importance in diagnosis are the following:

1. First, hæmorrhage. When it occurs under the skin it is of no diagnostic importance unless the injury was inflicted at some distance from the site of the hæmorrhage. In the case of fractures of the anterior fossa of the cranium, extravasation into the orbit is of some importance, since nearly all such fractures are attended with more or less bleeding into the fatty tissue of the orbit, and this extravasation after a certain time extends into the lids and conjunctiva. It is of especial assistance towards a diagnosis when there is no injury in the region of the forehead. Protrusion of the eye due to the extravasation is very rare, as also is a hæmatoma under the mucous membrane of the nose; more common is epistaxis, which may readily lead to hæmatemesis.

In the case of fractures of the middle fossa and temporal

Fig. 1

Fig 2

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PLATE XIII.

FRACTURE OF THE BASE OF THE SKULL FROM INJURY OF THE NASAL REGION.

The preparations were obtained from the body of a man aged twenty-eight, who was admitted into the Leipzig Hospital with the diagnosis of fracture of the nose, and who died of meningitis.

Fig. 1 shows impaction of the nasal and part of the ethmoid bone, which project into the interior of the cranium.

In fig. 2 the same is indicated from the front, and the complicated nature of the fracture shown.

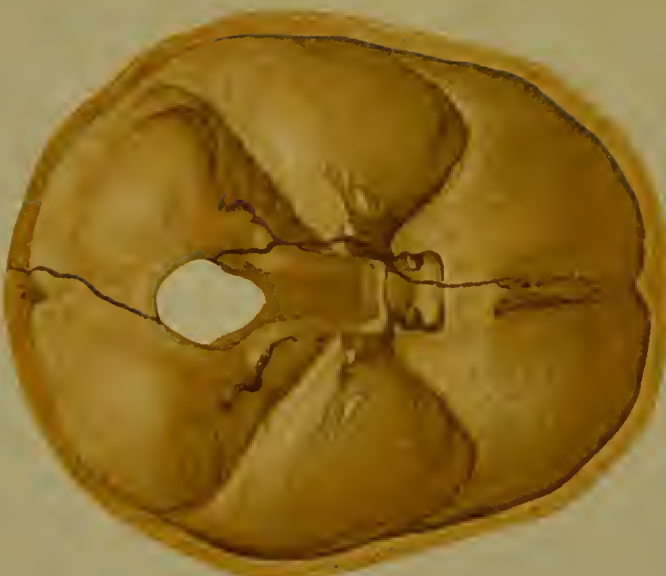

Fig. 2

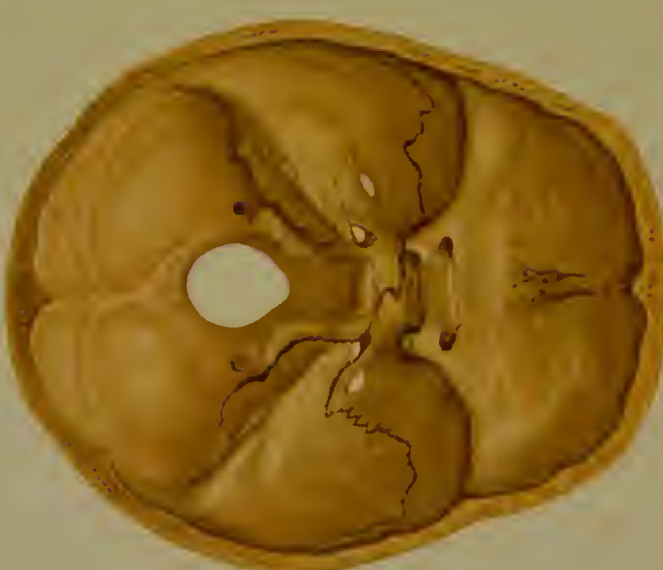

Fig. 1

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PLATE XIV.

FRACTURE OF THE BASE OF THE SKULL.

Fig. 1.—Fracture of the base from antero-posterior pressure. The patient, a man aged thirty-five, sustained a fall of ten feet on his head. At the autopsy this fracture, passing through the foramen magnum, was found. (From Hutchinson's 'Illustrations of Clinical Surgery,' vol. i, pl. xxx.)

Fig. 2.—Transverse fracture of the base of the skull produced experimentally on the dead subject by forcible pressure exerted across the skull. The result is precisely analogous to that shown in fig. 1.

bone, bleeding from the ear is often observed, and naturally a fracture of the base to cause such bleeding must rupture the membrana tympani. In the diagnosis we have to remember the possibility of entrance of blood into the ear from outside, rupture of the membrana tympani, or a fracture of the anterior or posterior wall of the bony meatus without implication of the cranial base. In the case of fractures of the posterior fossa, an extravasation around the mastoid process appearing some days after the accident is of some diagnostic importance.

2. Escape of brain matter is met with but seldom, and only in the worst cases of fracture. Of course, when it does occur, it is a sure sign of fractured skull with simultaneous rupture of the dura mater and crushing of the brain. The escape of cerebral matter from the ear is, perhaps, more frequently met with than elsewhere, though much more often it is the cerebro-spinal fluid which exudes. This occurs after the cessation of hæmorrhage from the ear (*i. e.* within twenty-four hours after the injury). A considerable amount of fluid usually escapes, and one can collect it drop by drop in a test-tube. The fluid is clear (when free from blood), of alkaline reaction, precipitates but little on boiling; it contains hardly any albumen, but some sugar and a great deal of sodium chloride. Such an escape of serous fluid is a sure sign of fracture of the base and rupture of the membranes, but is a much rarer symptom than hæmorrhage from the ear.

3. Lesions of the nerves passing through the base of the skull. If this symptom is observed directly or soon after the accident, one suspects a tear or crush of the nerve involved within its bony canal. If the paralysis of one or more cranial nerves comes on later, it may be the result of an inflammation spreading from the outer surface of the skull, which may lead to fatal basal meningitis.[1] The nerves most

[1] Professor Helferich, in the original, makes this statement even stronger, *i. e.* that such paralysis of deferred onset *is* always the result. However, we see sometimes facial paralysis coming on a week or more after a fractured base, and ultimately clearing up more or less completely, without any evidence of its being due to meningitis. In one such case in which the patient died a few weeks after the accident (though not from meningitis) the nerve was found

frequently injured in fractured base are the facial and the auditory, a fact easily explained by their course through the petrous bone, and the frequency of fractures in this region. Köhler observed in 48 cases of fracture of the base that facial paralysis was present 22 times, and paralysis of the sixth nerve only twice. Battle recorded, out of 168 cases of fractured base, tearing of the olfactory nerve in 2 cases, paralysis of the sixth nerve 5 cases, paralysis of the facial nerve 15 cases, paralysis of the auditory nerve 14 cases, blindness from extravasation of blood in the optic nerve sheath 8 cases.[1]

The Course and Prognosis of Fractures of the Base.

Whilst it was formerly believed that fractures of the base were invariably fatal lesions, we know now through clinical and post-mortem observation that these fractures may be recovered from if they have not been complicated by too severe crushing of the brain, or intra-cranial hæmorrhage. Evidence of damage to the brain is seldom wanting in cases of fractured base, the slightest form thereof being due to a shaking of the brain (commotio cerebri), a condition indicated by loss of consciousness, vomiting, and disturbance of the heart's action (usually slowing of the pulse). The sym-

to be inflamed within the aqueduct of Fallopius as it bent downwards. (Orig. obs.)—J. H.

[1] *Optic neuritis after fracture of the skull.*—This symptom, though not common, is of much interest. When it develops several days have always elapsed from the date of injury. It may occur (1) with septic meningitis from fractured base, &c.; (2) with abscess of the brain following compound fracture of the vault; (3) with laceration of the brain accompanying fracture of the base; and (4) following concussion without evidence of fracture.

Many times optic neuritis has been observed in cases of injury to the head which have perfectly recovered. In some of these probably there is a mild form of inflammation at the base of the brain spreading to the sheath of the optic nerves (Edmunds and Lawford, 'Trans. Ophth. Soc.,' vol. ii, p. 208; ibid., vol. v; and Battle, 'Brit. Med. Journ.,' July, 1890).

Optic neuritis after injury to the head may be unaccompanied by any defect of sight that is noticed by the patient; on the other hand, blindness of one or both eyes may result from laceration of the optic nerve or hæmorrhage into its sheath due to fractured base.—J. H.

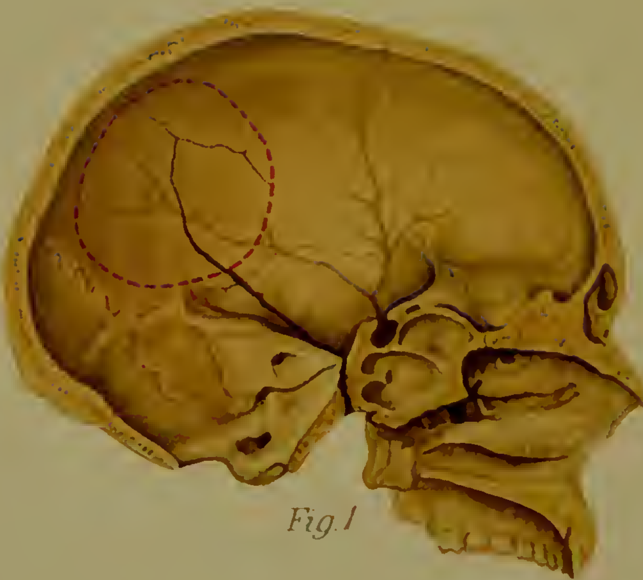

Fig. 1

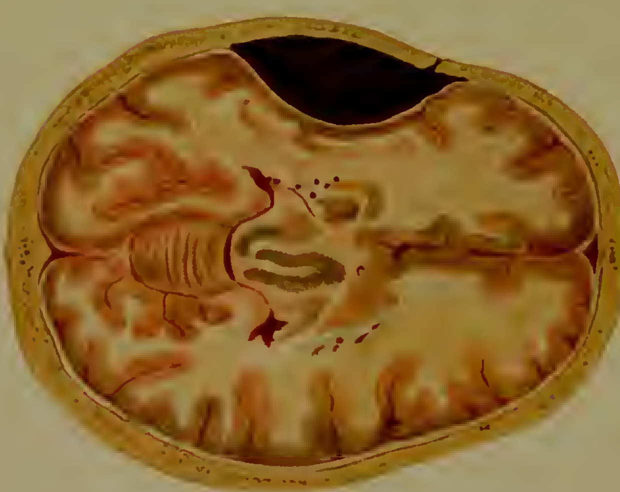

Fig. 2

Lith.Anst.v. F. Reichhold München

PLATE XV.

FRACTURE OF THE SKULL WITH RUPTURE OF THE MIDDLE MENINGEAL ARTERY.

Fig. 1.—From a workman aged twenty, who fell from the fourth story of a house. On admission into the hospital there was an extravasation of blood in the left temporal region, a perceptible fracture of the squamous portion of the left temporal bone, followed by escape of cerebro-spinal fluid from the left ear and paralysis of the left side of the face, and of both arm and leg on the right side. Death resulted from tetanus due to infection of a contused wound in the thigh. The drawing shows the position of an extravasation of blood from the posterior branch of the middle meningeal artery, together with the bifurcation of this artery, the line of fracture, &c.

Fig. 2.—Horizontal section through the skull with the contained brain. There is a large extravasation of blood from the middle meningeal artery, between the brain and the dura mater. This has been caused by a fracture through the temporal bone; the brain is compressed and displaced inwards. (From Hutchinson's 'Illustrations of Clinical Surgery,' vol. ii, pl. liv.)

ptoms soon clear off, and in any case, if the unconsciousness lasts more than a few hours, or at most one to one and a half days, a more severe lesion of the brain is to be suspected. Sometimes the patient is found to have lost all recollection of the events immediately preceding the accident.

Uncomplicated cases of shaking of the brain are less common than used to be supposed. Shaking of the brain from side to side within the skull is unlikely to occur ; and much more probable, as a result of severe force acting on the skull, is a general squeezing of the whole brain, especially when one recollects the elasticity of the skull. Where this squeezing force is applied there are probably actual contusions and extravasation of blood in the cortex, followed perhaps by well-marked softening. These definite anatomical changes may also be present at the opposite part of the brain to the seat of injury.

According to the importance of the cortical area affected, characteristic nervous symptoms from damage of certain centres may be present. If there is crushing of the brain, and intra-dural hæmorrhage in the region of the anterior and middle fossæ of the skull, great elevation of temperature (not due to meningitis) may be expected.

We have now to note *compression of the brain.* It has been thoroughly made out from clinical observation and experiments that a relatively large part of the skull must be driven in, in order to produce the symptoms of compression of the brain. The most typical cases of the latter are due to rupture of the middle meningeal artery, followed by extravasation of blood between the dura mater and the bone, which depresses the surface of the brain as shown in Plate XV, fig. 2.[1]

[1] Hæmorrhage from the middle meningeal artery in most cases pushes the dura mater inwards opposite the temporo-sphenoidal lobe in the middle fossa of the skull. It reaches inwards as far as the large foramina for the branches of the fifth nerve, but never extends across the middle line It is, however, possible for an extra-dural hæmorrhage to be present on both sides on the same patient, owing to a rupture of both meningeal arteries. There is a specimen illustrating this in the London Hospital Museum. In this case the surgeon trephined on both sides, and secured the bleeding vessels by ligatures passed through the dura mater. There is no doubt that the violent compression of the skull when the fracture occurs may force the

In typical cases of this kind the early symptoms of concussion clear off, the patient recovers consciousness, and seems to be on the high road to recovery, when fresh symptoms supervene; at first those of cerebral irritation, and later those of paralysis, followed by renewed unconsciousness, slowing of the pulse, and finally deep coma. In such cases trephining over the site of extravasation, and if necessary ligature of the torn meningeal artery, can alone save the patient.[1]

For the preceding reasons (without considering their rarer complications) fractures of the base are attended with a high mortality; those of the middle fossa are by far the most frequent, but cases of fracture through the posterior fossa are on the whole the most fatal.

dura mater away from the bone, and thus favour meningeal hæmorrhage. In fact, by this means a fatal rupture of the meningeal artery may be produced without a fracture of any part of the skull. This happened in the case of a young girl on whom I operated by trephining and subsequent ligature of the external carotid artery (see 'Med. Press and Circular,' Dec. 15th, 1895).

If the fracture is chiefly of the upper part of the skull, a meningeal branch may be torn, and blood poured out towards tho vertex, *i. e.* wholly above the level of the ear. These cases are of particular interest since the usual symptoms may be considerably modified, and, further, it may be necessary to trephine at a point higher and more posterior to the one usually recommended.—J. H.

[1] The symptoms due to hæmorrhage on the surface of the brain may be identical with those from rupture of a meningeal artery. Hence if trephining has been done in a case of compression following fracture which is supposed to be due to rupture of this artery, and yet no blood is found outside the dura mater, the surgeon is justified in incising the latter, and he may succeed in letting out an extravasation in the subarachnoid spaces. Although the prognosis is necessarily very bad, owing to the fact that the blood is usually spread out over a large area and towards the base, and because of the accompanying injury to the brain, now and then the patient's life would be saved by trephining. It is noteworthy that in these cases of surface laceration and hæmorrhage there is often marked rise of temperature, which before the patient's death may reach 105° to 108°. The same phenomenon is observed in some cases of steadily increasing hæmorrhage from the meningeal artery, and has nothing to do with meningitis. It is not observed in those cases of fracture of the skull which are fatal within a few hours of the injury. In order to produce it the extravasation, whether on the inner or outer side of the dura mater, must be gradually poured out.—J. H.

Treatment.—As a rule this consists, in uncomplicated cases, in keeping the patient perfectly at rest, applying cold to the head, perhaps feeding with the œsophageal tube, &c. When there is bleeding from the ear, it is a question whether syringing with disinfectants should be carried out. I consider it impossible to obtain in this way a complete disinfection of the ear, and that syringing is, moreover, attended with risk of carrying infection towards the meninges; and recommend, therefore, merely a thorough cleansing of the external meatus, and the skin around, with the use of sterilised cotton wool.

Remembering that crushing of the brain is perhaps less directly a cause of death than the pressure of the extravasated blood which accompanies it, it is reasonable to recommend trephining in such cases, and of late years some most encouraging results have been obtained from this operation.

Fractures of the skull unite in the usual way by bone, but with the formation of less callus [1] than is the case elsewhere, for the reasons that the parts are kept perfectly at rest in the case of the skull, and that its periosteum forms new bone with difficulty. Occasionally after fractures of the vault in young children a gap may be left in the bone, leading to a meningocele. (See note on next page.)

[1] Sabre wounds of the skull proved long ago that large fragments or flaps of bone might unite well after their detachment. There is a remarkable series illustrating this in the Royal College of Surgeons' Museum (London), Nos. 862 to 868, the specimens forming which were doubtless obtained from soldiers who had served in the Napoleonic wars. Flaps of bone from two to three inches in diameter, which had been severed more or less completely from the rest of the skull, are here seen to have united firmly, although the wounds no doubt suppurated. The bony rounding of the edges is very marked in nearly all the specimens. Of late years surgeons have learnt that fragments of trephined bone may safely be replaced after an operation, and that even a disc two inches in diameter may unite well with the cranial vault if replaced—that it is even safe to turn down a large bony flap four inches or more wide from the side of the cranium for exploratory purposes. All these facts were clearly taught by such museum specimens of fracture as have been mentioned.—J. H.

In young children depressed fracture of the skull, whilst it can hardly be attended with splintering of the internal table, and whilst the depression, however considerable, is almost always obliterated in course of time, may yet have special dangers of its own. The dura mater may be torn, and the subarachnoid fluid escaping through the skull at the site of the fracture gradually form a large tumour beneath the scalp. The aperture in such cases tends to enlarge, and the fluid-containing cavity may, owing to an injury to the cortex, come to communicate with the ventricles of the brain. It will be understood that this pulsating tumour may form without any wound of the scalp. It is a dangerous complication owing to the risk of meningitis (see valuable papers by Rickman Godlee, 'Path. Trans.,' 1885, p. 313; Clement Lucas, 'Guy's Hospital Reports,' 1876, *et seq.;* and T. Smith, 'St. Bart.'s Hospital Reports,' 1885).—J. H.

Fractures of the Bones of the Face.

The bones of the face are so accessible to examination from the exterior or from the nasal and oral cavities that their fractures offer hardly any difficulty in diagnosis, and, although almost invariably compound, they are attended with little risk of infection or special complication.

Fractures of the nasal bones and of the septum lead as a rule to marked deformity (traumatic saddle nose). This deformity can in recent cases be to some extent removed by elevation with forceps. Amongst the symptoms the sanguineous effusion under the mucous membrane, epistaxis, and occasionally emphysema of the skin of the face are to be noted.

Fractures of the malar bone and of the upper jaw result from direct injury, very often from a kick with a horse's hoof, and are therefore frequently complicated with skin wounds. There is little difficulty in diagnosis, and the treatment consists mainly in re-position and fixation of any displaced portion of the alveolar margin. This is best effected with the aid of the dental surgeon, whereby loosened teeth may often be retained. I have succeeded in obtaining good union of such a displaced fragment by means of fixing it in place by a steel peg. Great attention must be paid to keeping the mouth clean by syringing with three per cent. solution of boracic acid, and careful feeding with fluids.

Fig. 3b

Fig. 3a

Fig. 2

Fig. 1

Fig. 4b

Fig. 4a

Lith. Anst. v. F. Reichhold, München

PLATE XVI.

FRACTURES OF THE LOWER JAW.

Fig. 1.—Recent fracture in the body of the lower jaw, running obliquely up to the region of the molar teeth.

Fig. 2.—Fracture running obliquely through the body of the lower jaw, and through both condyles. This interesting form of fracture is certainly the result of a very severe injury, sustained probably through a fall on the chin (compare with this Plate XII, fig. 3, and the remarks on the latter).

Figs. 3 *a*, *b*.—From a case of fracture of the right condyle and neck of the lower jaw. The fragment broken off has been displaced downwards and united in this position.

Figs. 4, 4 *a*.—Hammond's wire splint for fractures of the lower jaw.

Fractures of the Lower Jaw

are more numerous than those of the upper. Their diagnosis is so easy, as a rule, that little needs to be said about it. In fractures right through the horizontal ramus there is commonly displacement downwards of the anterior fragment, owing to the action of the digastric and the other muscles of the chin, whilst the other fragment is pressed upwards by the masseter, &c.[1] A certain amount of lateral displacement and overlapping is rarely absent, so that the arch of the lower jaw is diminished. Comminuted fractures are not uncommon. The cause is nearly always direct violence, blows, kicks, shot wounds, &c., though indirect fracture may result from a fall on the chin or a violent force applied to the side of the bone.

Treatment.—It must be remembered that fractures of the lower jaw are always compound, even when there is no wound of the skin. For this reason great pains must be taken in disinfecting the mouth, and where the gums are much torn the use of iodoform gauze is indicated until the wounds can be sewn up with appropriate sutures.[2] The reduction of the displacement by direct pressure is as a rule easy, but to retain the fragments in good position is difficult owing to muscular action. Fortunately we are no longer confined to the use of splints and bandages which press the lower jaw against the upper one; with the help of the dentist fixation can be secured by means of splints fastened to the teeth on either side of the fracture, and sometimes the use of thin silver wire around tho adjoining teeth will suffice. Where these measures are impracticable we may be compelled to employ the old form of apparatus, or to drill the bone and fix the

[1] Two thirds of the fractures of the lower jaw occur in the horizontal ramus between the lateral incision and the second bicuspid. This is owing to the bone being here comparatively thin, and further weakened by the presence of the deep socket for the canine tooth. Fractures through the symphysis menti are extremely rare, owing to the great density of the bone in this position.—J. H.

[2] It is very rarely, if ever, that sutures can be usefully applied to the torn mucous membrane of the gums.

fragments by stout silver wire. Fractures of the alveolar portion are common from rough or unskilled attempts at tooth extraction,[1] especially from the use of the key.

Fig. 23

Fig. 24.

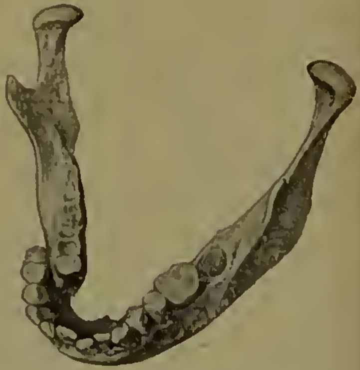

Fig. 23.—Displacement from muscular action following fractured lower jaw.

Fig. 24.—Preparation of a fracture of the lower jaw, with lateral displacement.

One of the rarer forms of fracture of the lower jaw is that of the condyle (see Plate XVI, figs. 2, 3 *a*, and 3 *b*); another is that of the coronoid process, which may be torn off by the temporal muscle, the displaced fragment uniting by fibrous tissue with a wide interval.

[1] These attempts are a fertile cause of necrosis of the jaw. In young children especially the extent of bone which may require removal is remarkable. Thus in the case of a child aged four a fracture from roughness in extracting a tooth led to necrosis of the ascending ramus. I removed the whole of this, including the coronoid process and the neck of the jaw, as one sequestrum. A complete case of new bone was being formed at the time, and in such cases the ultimate result as regards firmness in biting is surprising.—J. H.

A. *Dislocation of the Lower Jaw.*

Symmetrical dislocation forwards is fairly frequent, being produced in wide opening of the mouth (yawning, vomiting, &c.).[1] It is well known that in ordinary opening of the mouth the condyle travels forwards beneath the articular eminence. The axis of this movement passes through the

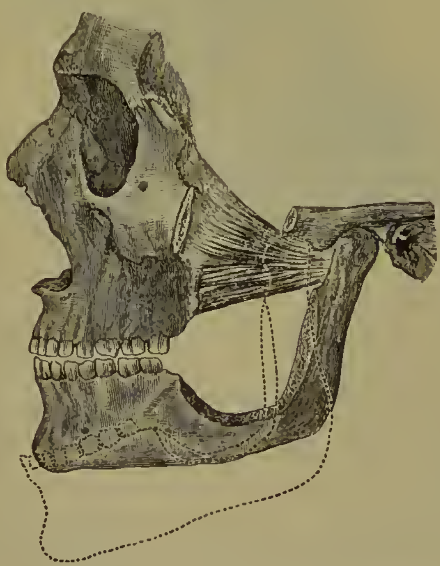

Fig. 25.—Action of the external pterygoid muscle with regard to dislocation of the lower jaw.

beginning of the inferior dental groove above the lingula on either side. If this movement is carried further the condyle rides over the eminence into the temporal fossa, where it is fixed by the contraction of the muscles, especially the temporal. This dislocation is more common in women than in men.

The symptoms of the dislocation are simple enough ;—wide opening of the mouth, projection of the lower row of teeth in front of the upper, complete inability of the patient to

[1] Dislocation of the jaw may occur during the manipulations of the dentist, and may be overlooked for a time.

close the mouth herself, absence of the condyle from its normal place and its presence further forwards.[1]

Fig. 26.—Method of reducing a dislocation of the lower jaw. The operator's thumbs should be guarded.

When the jaw is dislocated on one side only, the mouth is opened wide and the chin pushed over somewhat towards the sound side.

The capsule of the joint is as a rule uninjured, but much stretched (see Plate XVII, fig. 1). Children are not liable to this dislocation.

The prognosis is favourable, but there is in some cases a marked tendency to recurrence of dislocation. To reduce it the lower jaw must first be pressed downwards and then backwards (this is best accomplished by means of the two thumbs pressing on the alveolar portion of the jaw). As the condyle slides over the articular eminence one feels a sudden cessation of the resistance which had been caused by muscular contraction or stretching.

[1] Probably the pain felt is largely due to stretching of the lingual or the inferior dental nerve, and the increased flow of saliva may be due to the same cause.

Fig 1

Fig 2

Fig. 3

PLATE XVII.

DISLOCATION FORWARD OF THE LOWER JAW.

Fig. 1.—Symmetrical dislocation of the lower jaw produced experimentally on the dead subject. The mouth is wide open, the chin pushed forwards. The condyle of the lower jaw is placed in front of the eminentia articularis, behind which is seen the empty glenoid fossa ; the capsule of the joint has not been torn, but merely stretched. The temporal muscle is in a condition of great tension, owing to the forward displacement of the coronoid process, and therefore presses the condyle against the bone in front of the articular eminence.

Fig. 2.—Normal relations of the articulation when the mouth is closed.

Fig. 3.—The same when the mouth is opened ; the condyle rests on the articular eminence.

B. *Backward Dislocation of the Lower Jaw.*

This is an extreme rarity, practically confined to women. In this form the condyle (owing to yawning, spasmodic muscular contraction, a fall, &c.) rides over the small tympanic tubercle which borders the articulation behind, and reaches the fossa by the stylo-mastoid foramen, almost under the external auditory meatus.

To effect reduction, pressure should be made on the lower jaw downwards and backwards, followed by movement to and fro; or forcible opening of the mouth by means of a gag may succeed.

[C. *Fractures of the Hyoid Bone and Thyroid Cartilage.*

These are of sufficient interest to deserve a few words, especially as there is a fallacy of diagnosis to be guarded against in connection with injuries to the neck. If the normal larynx is held between fingers and thumb and moved laterally over the cervical spine, a sort of crepitus is often felt. This symptom, should the patient have sustained any injury to the neck, may readily lead the surgeon to an erroneous diagnosis of fracture of the hyoid bone or thyroid cartilage. The mistake is of especial importance, since in such a case the patient is probably examined on account of some violence which may be the origin of a criminal charge. No one who has not tried the experiment mentioned would credit how deceptive the feeling of crepitus is. As a rule, fracture of the hyoid bone or thyroid cartilage is due to such force (whether the larynx is grasped by the hand of an assailant or struck by his fist, &c.) that marked evidence of external bruising accompanies it, and there is, moreover, much respiratory distress. Some hyoid bones, however, are so lightly made, and therefore fragile, that very slight violence might break them (this is especially the case in women). According to Dr. Gibb, in three out of fourteen cases of

fracture of the hyoid, muscular action alone was the cause. Probably the most frequent site for the fracture is about the junction of the great cornu with the body of the hyoid, and the fracture may be bilateral. Owing to the action of the middle constrictor union is almost sure to occur with the cornu bent inwards. It may be noted that the hyoid bone is often fractured in cases of hanging.

Fracture of the thyroid cartilage is unlikely but not impossible to occur before the cartilage has begun to ossify; it is in any case a very serious injury, owing to the accompanying shock and dyspnœa and the subsequent risk of œdema glottidis. Several cases of fracture of the tracheal rings have been recorded.—J. H.]

Fractures and Dislocations of the Spine.

Fractures of the vertebral bodies, of which those of the fifth and sixth cervical vertebræ and of the lowest dorsal and upper lumbar ones are the most frequent, occur as the result of great violence. This great force is required owing to the extreme elasticity of the spine, which is due to the fact that one fourth of its length consists of intervertebral discs. How mobile the spinal column can become through practice is shown in the so-called "gutta-percha men," who are able to bend to a sharp angle the cervical and lumbar portions of their spinal column. It is at these two points that fractures are most commonly observed, since the compressing force acts here at its greatest advantage. It will be remembered that when a force acts upon a column of varying elasticity it will break most easily where a more flexible joins a less flexible part; and these conditions are present at the junction between the twelfth dorsal and first lumbar vertebræ, and still more in the lower cervical region.

Fractures of the vertebral bodies from direct violence are extremely rare, and even when the back is run over indirect violence as a cause of the fracture is not excluded. Fractures from indirect violence especially involve the bodies of the vertebræ, either by means of forcible flexion, or of compression, or of a force causing antero-posterior displacement. As a rule

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PLATE XVIII.

FRACTURE OF THE SIXTH AND SEVENTH CERVICAL VERTEBRÆ WITH CRUSHING OF THE SPINAL CORD.

The patient, a woman aged thirty-three, lived seven days after the accident, death being due to respiratory failure. During life there was sensory and motor paralysis of the trunk and lower limbs, with partial paralysis of the upper limbs. The upper limit of the sensory paralysis was at the level of the third rib. There was retention of urine. In the region of the sixth cervical spine there was marked projection. Under an anæsthetic this could be obliterated. The treatment consisted in the use of a water-bed, and of weight extension applied to the head.

The illustration shows extremely well fracture of the two vertebral bodies and the projection of the seventh backwards, producing narrowing of the vertebral canal and crushing of the spinal cord.

there is a combination of these factors. The accident may occur in a fall upon the back of the head, on to the pelvis, or the feet, sometimes from a heavy fall of earth, &c., upon the back, whilst at the moment of the accident the vertebral column as a whole is more or less rigid owing to muscular contraction.

Different forms of fracture of the vertebral bodies may be distinguished :

1. Oblique fractures, the obliquity being generally from above downwards and forwards, with a marked tendency to antero-posterior displacement. These are the most common (see Plate XVIII).

2. Longitudinal fractures, which are very rare.

3. Transverse fractures, which are caused by strong compression and forced flexion of the column, usually attended by impaction and consequent diminution of the vertical height of the bone. Although as a rule the outward appearance of the column in such cases may be but little altered, the vertebral canal may be much narrowed, and the spinal cord crushed (see Plate XIX). Detachment of fragments of bone and displacement of the intervertebral discs may be present as complications.

Symptoms.—Apart from the condition of shock, which is so often present after such severe injuries, one of the most pronounced features is the kyphosis resulting from shortening of the front of the vertebral column, due to impaction or to antero-posterior displacement.

Contraction of the powerful muscles of the spine and secondary movements may also have something to do with it. If the spine is fractured obliquely there may also be some lateral displacement. A slight degree of kyphosis is nevertheless hard to make out, and in many cases the only local sign may be a diminution of the normal lordosis, or hollowing of the spine. A well-marked pain at one spot is then a symptom of some value ; naturally there is no abnormal mobility, and crepitus is hardly ever to be obtained.

When the spinal cord has been completely crushed we have paralysis of the lower and upper extremities (according to the site of the fracture), damage to the functions of bladder and rectum, sometimes a great rise of temperature

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if the lower cervical region has been involved, and speedy death from respiratory failure. The reflexes are variously affected: as a rule when the cord has been crushed they are increased; in slighter cases they may be unaltered,[1] or indeed increased.

The diagnosis of a fracture of the vertebral bodies is self-evident in the really severe cases, in which there is kyphosis and symptoms of a complete transverse lesion of the spinal cord. It must, however, be remembered that in many cases of fracture of the vertebral bodies the spinal cord and the nerve roots escape injury. A glance at the fracture in the upper dorsal region shown on Plate XIX shows that the spinal cord here would not have been damaged.

In such cases the force is less than usual, and the kyphosis or other visible deformity of the spine may be absent. Occasionally local pain produced by sudden pressure on the head may be of value in cases where the injury has occurred some little time before.

The prognosis of these fractures depends on the extent of damage to the spinal cord. In itself the fracture of the vertebral bodies may readily unite with bone, and many patients survive after this injury, capable of working, so long as the spinal cord has not been damaged; but if symptoms of the latter injury are present the case is always an anxious one. Even if myelitis does not supervene, other dangers threaten. The vesical paralysis necessitates the use of a catheter several times daily; and although it is possible and imperative to carry this out with thorough aseptic precautions, only too often in practice it happens that cystitis from infection by means of a catheter is produced, and that subsequent septic pyelo-nephritis gradually proves fatal. A second danger is produced by the anæsthesia of the paralysed parts; not only may acute trophic disturbances, particularly after injury to the cervical part of the spinal cord, supervene, but from the simple absence of feeling in the skin, persistent pressure, especially where the skin is often moist, as in the sacral region, may lead to sores. No patients require more careful nursing, and constant oversight on the part of the

[1] This is hardly correct. After complete crushing of the cord in all cases the knee reflexes, &c., are lost for at any rate a long period of time.—J. H.

Fig. 1a

Fig. 1b

Fig. 1

PLATE XIX.

DOUBLE FRACTURE WITH IMPACTION OF THE SPINAL COLUMN.

The preparation was obtained from a slater, aged thirty, who fell, on the 28th May, 1894, from a roof about sixty feet above the ground. His back first struck the stony ground, and then his feet. He was unconscious for twenty-four hours. On admission there was pain in the upper and lower parts of the dorsal spine. There was no motor paralysis, but anæsthesia in the back of the thighs and the genital regions. After the second day there was incontinence of urine and fæces. The case was complicated by an impacted fracture of the left os calcis, and a deep wound in the sole of the right foot. Later he developed bedsores and erysipelas, and one leg had to be amputated. He died on the 14th November, 1894, five months after the accident. The illustration shows the double impacted or compression fracture; the fifth dorsal vertebra is driven into the sixth, together with the intervening fibro-cartilage, but the spinal canal is not materially narrowed (see fig. 1 *a*). The body of the first lumbar vertebra has been squeezed out of shape in all directions. The vertebral canal opposite to it is greatly narrowed, measuring only 4 mm. from before backwards, and the cauda equina and their membranes were here adherent to the bone. The fracture has evidently occurred through forcible bending forward of the column.

surgeon, than those with fracture of the spine with paralysis of a large part of the body. The use of a soft and smooth bed (water-pillow or water-bed), frequent slight changes of position, the greatest care in keeping the skin clean and dry and in preventing it from being soiled, and thorough antiseptic precautions in the use of a catheter are absolutely necessary.

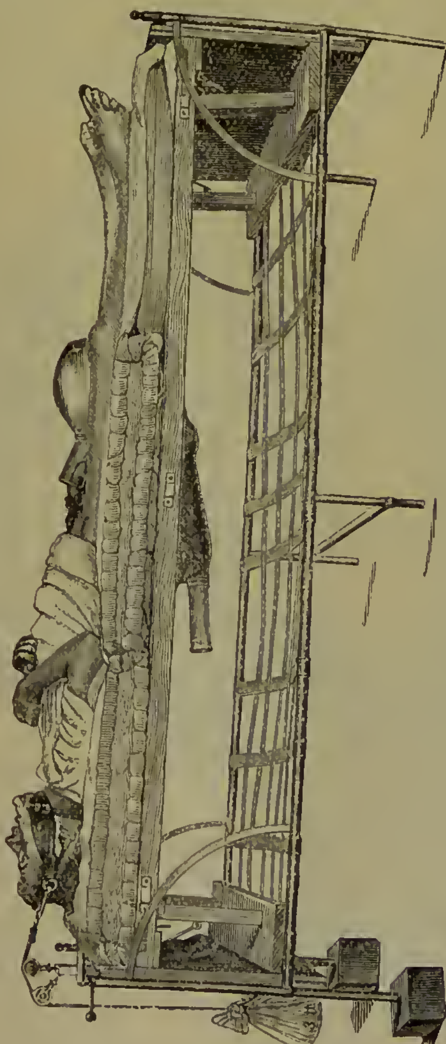

Fig. 27.—Illustrating the treatment of a fracture of the cervical spine.

Case of a man aged twenty, who fell on to his head from the horizontal bar. Fracture through the sixth and seventh cervical vertebræ, local pain on pressure, and extravasation of blood. Motor, sensory, and reflex paralysis from the level of the fourth rib downwards. Retention of urine and fæces. At first the upper extremities were free, but later developed partial motor and sensory paralysis. Regular catheterism; in a short time cystitis and bed-sores. Death on the 1st October (two months after admission, from pyelo-nephritis).

The site of fracture does not always require special care. With fractures of the cervical region, weight extension

applied to the head (see Fig. 27) may be useful, though often the patient is more comfortable simply lying on his back, with the head and neck steadied by pillows. Fractures in the dorsal and lumbar regions of the spine can also, by means of a special apparatus, have weight extension applied to them. After a time a plaster-of-Paris jacket will be a useful support.

Fig. 28.

Fig. 29.

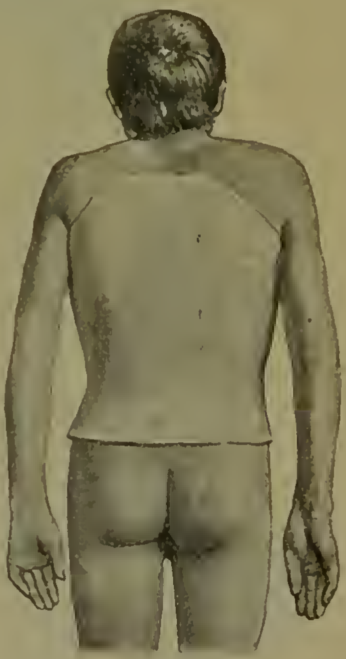

Fig. 28.—Angular kyphosis in the region of the eighth or ninth dorsal vertebræ from a fall of five yards on to the back. As soon as he became conscious the patient was able to walk with assistance to his home. Six days later he was admitted on account of pain in the region of the fracture. There were no other nervous symptoms, and he made a good recovery.

Fig. 29.—Same patient as shown in Fig. 29, with a Sayre's jacket applied. The latter somewhat conceals the deformity. The jacket would have to reach lower down and take a larger hold of the pelvis if the fracture were in the lower dorsal or lumbar region.

Operations with the view of removing pressure from the spinal cord have been but rarely carried out, and quite exceptionally have been of use.

Even in less severe cases, in which damage to the spinal cord from crushing, or blood extravasation, or injury of the nerve-roots leaving the canal is not present, the treatment must be carefully carried out, since prolonged rest of the spinal column in a favourable position is necessary for consolidation of the fracture, and the avoidance of secondary displacement at the site of the injury; since the mechanical pressure of the spinal column in the upright position, and during work, is an enormous one, and the production of new bone not very rapid or abundant. Hence an appropriate support should be worn for long after the fracture.

A. *Fractures of the Vertebral Arches and Processes.*

These are not common, and may be divided into fractures of the spinous processes of the transverse or articular and of the laminæ. They are illustrated in Figs. 30 to 32; and it may be noted, that a detached part of the bone may be driven into the spinal canal. They usually complicate fractures of the vertebral bodies.

[On the important question of operation by trephining the spine in cases of fracture-dislocation, Thorburn's conclusions

Fig. 30.—Lumbar vertebra, fracture of the spinous process.

may be quoted. His work on 'The Surgery of the Spinal Cord' is a most valuable and complete treatise on the subject. He sums up, "The operation of trephining the spine for traumatic lesions should be abandoned except in cases of injury to the cauda equina, since both *a priori* argument and the results of published cases show that it is unlikely to be of service." If the cord has sustained a complete transverse lesion, *i. e.* if it has been once completely crushed, so as to

be transversely divided, no operation can possibly lead to union of the two segments with recovery of function. Once

Fig. 31.

Fig. 32.

Fig. 31.—Fifth cervical vertebra, fractured through its pedicle.
Fig. 32.—Seventh cervical vertebra, with fracture of each lamina.

divided the spinal cord is always divided. On the other hand, a fracture-dislocation at or below the first lumbar vertebra will involve the cauda equina, which may recover from severe contusion or even division, exactly as other nerve-trunks do. Out of the sixty-one cases Thorburn collected in which an operation was performed for fracture-dislocation of the spine, in only seven was there a *boná fide* improvement. In every one of these seven the lesion was at or below the last two dorsal or the first lumbar vertebræ. Limiting surgical interference then to the lumbar region of the spine, we must still further exclude those cases which are steadily regaining power. "I should be inclined to lay down the rough rule, that if at the end of six weeks there is no recovery, or if recovery is at a standstill, then, and then only, should we operate for crushes of the cauda equina" (Thorburn, p. 162). The writer makes one exception to the above rule, viz. that early operation may be justified in cases where the vertebral arches have alone been fractured and driven on to the spinal cord; these cases are, however, extremely rare.—J. H.]

Fig. 1a

Fig. 1b

Fig. 2a

Fig. 2b

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PLATE XX.

DISLOCATION OF THE CERVICAL VERTEBRÆ.

These drawings are made from artificially produced dislocations.

Figs. 1 *a*, *b*, show unilateral displacement of the fourth vertebra, the articular process of which projects in front of that of the fifth. The forward projection of the vertebral body on this side is shown in fig. 1 *a*. The adduction of the head to the right, and the deviation of the spinous processes, are seen in fig. 1 *b*.

Figs. 2 *a*, *b*.—Symmetrical dislocation of the fourth cervical vertebra forwards from forced flexion.

B. *Dislocation of the Spine.*

In the dorsal and lumbar regions pure dislocation is excessively rare; in the cervical region it is of practical importance. One has to distinguish between dislocation due to forced flexion, and that due to rotation of the cervical spine.

In the first variety the ligaments at the back are torn, and the vertebra above is displaced in front of the lower one (Plate XX, fig. 2). In the latter the dislocation is due to strong abduction towards the side which is not dislocated, together with a rotation forward of the vertebra above (see Plate XX, fig. 1). The symptoms sometimes are perfectly characteristic: not only may the line of the spinous processes be interrupted, but the projection of the vertebral body may be felt through the mouth with the finger. The neck is always strongly bent forwards. This statement refers to the dislocation from forced flexion. In that due to rotation the head is turned towards the sound side, the difference in the line of spinous processes is much less marked. The spinal cord may be damaged, with the results already referred to; the phrenic nerve will escape if the dislocation is below the fourth cervical vertebra. The prognosis depends upon the damage to the cord, &c., and the results of the attempt at reduction. We may specially note the dislocation of the occiput on the atlas from violent flexion or extension of the head, and of the atlas, both of them as a rule immediately fatal from the injury to the cord.

The possibility of true dislocation in the region of the dorsal and lumbar vertebræ has been proved on the post-mortem table, but must be almost impossible to recognise in the living subject, *i. e.* it must be so difficult to exclude fracture.

Treatment.—Reduction should be attempted, the patient being deeply anæsthetised. In the case of rotatory displacement the neck should be strongly adducted to the sound side, in order to overcome the locking of one articular process

over the other; when this has been effected the head is drawn backwards on the injured side.

The manipulation must be made not entirely with the head, but also by means of the vertebræ above the site of the dislocation. In the case of dislocation from flexion, first one and then the other side of the neck should be treated in the manner first mentioned. After reduction it is necessary to keep the neck fixed for some weeks in a suitable apparatus.

Fig. 1

Fig. 1a

Fig. 2

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PLATE XXI.

FRACTURES OF THE RIBS.

Fig. 1.—Preparation obtained from the body of a man aged fifty-three. The ribs from the third to the tenth are fractured in the axillary line, and the four lower ones are also broken about the angles.

Fig. 1 *a*.—Horizontal section through the fourth rib, from the specimen figured above. The overlapping of the two fragments and their firm union are well seen.

Fig. 2.—Recently united fracture of a rib without displacement, seen in horizontal section. The formation of callus is very obvious.

CHAPTER III.

FRACTURES AND DISLOCATIONS OF THE RIBS, ETC.

FRACTURES of the ribs constitute about 15 per cent. of all fractures, but are extremely rare in children on account of the elasticity of their ribs. Naturally they are least often observed in the very moveable lowest ribs and the well-protected highest ones. The fracture may be due to direct or indirect violence, whether the pressure be exerted from before backwards or from side to side.

The pleura and lung are often wounded by the sharp fragments, and hence hæmoptysis, hæmothorax, pneumothorax, and perhaps wide-spread traumatic emphysema may result. The hæmothorax may require puncture ; the emphysema is of no real gravity, as a rule disappearing in a few days. The treatment consists in the application of strapping and bandage to the chest, and attention to any complications that may arise. The union is bony, as a rule without much displacement. Fractures of the rib cartilages are not so rare as is perhaps supposed. They unite with but little, if any, bony callus ; they are chiefly met with in the case of the fifth to the eighth ribs, the cartilages of which are the most exposed, and they are usually due to direct violence.[1]

[1] It has been clearly proved that fractures of the ribs may originate from sudden contraction of such muscles as the latissimus dorsi or the serratus magnus. In old age, or in such general atrophy as may accompany dementia, the ribs often lose their natural elasticity, become charged with fat, and very brittle. This is probably in some measure the explanation of the frequency of fractured ribs amongst the insane. But fracture from muscular action may occur in healthy strong adults ; in one such case I knew of, the accident occurred in the act of throwing a cricket ball.

The use of strapping and bandage is sometimes best dispensed with, as they may increase the respiratory difficulties. If the dyspnœa throws a

Dislocation of the Ribs.

It is only necessary to mention this extremely rare injury, which may occur either at the sternal or the vertebral end of the rib.

FRACTURE OF THE STERNUM.

This is due to direct violence, and is, as a rule, a very dangerous injury, on account of the internal viscera being frequently damaged at the same time.

In a fall with the head bent forwards the impact of the chin may fracture the sternum, and under opposite conditions (hyper-extension of the back) the bone may also be broken. The diagnosis is not difficult on account of the superficial position of the bone, and also since displacement is usually met with.[1]

Treatment.—In two recent cases I was able to relieve the displacement by weight extension on the head; to maintain the reduction it was necessary to keep a firm pillow behind the thorax.

serious strain on the right side of the heart, leading to cyanosis, venesection may be called for, though it will probably not be required in more than one out of fifty cases.—J. H.

[1] The same injury that leads to fracture of the spine or of the ribs may break the sternum; thus, out of nine cases of fractured sternum at St. George's Hospital, eight were complicated with fractured spine and six with fractured ribs (Holmes's 'System,' vol. i, p. 813). The diagnosis is not perhaps always so easy as the above statement would imply, and probably many cases are overlooked. There is an interesting specimen of separation between the manubrium and gladiolus sterni in the London Hospital Museum which illustrates this. It was obtained from a woman who fell out of window when drunk, sustaining various injuries. At the end of a few weeks an abscess over the sternum had developed, and when this was opened the fracture-dislocation was first recognised. She died of pyæmia seven weeks after the accident. The upper end of the sternum lay in an abscess cavity.—J. H.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

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PLATE XXII.

Fig. 1.—Horizontal section of a fracture of a costal cartilage. The fragments are much displaced, and bound together by scattered masses of bone.

Fig. 2.—Horizontal section showing fracture of the fifth costal cartilage and adjoining bone, with fibrous union.

Fig. 3.—Fracture of the body of the sternum produced artificially.

Fig. 4.—Fracture of the sternum united with overlapping.

Fractures and Dislocations of the Upper Extremity.

As a result of indirect violence to the upper extremity various lesions may follow; for instance, from a fall on the hand the patient may sustain either a Colles's fracture, a dislocation of the elbow, of the shoulder, a fracture of the humerus, or (especially in children) a fracture of the clavicle.

Fractures of the Clavicle

form about 15 per cent. of all fractures, and the most common site is about the middle of the bone, or rather nearer its sternal end. They are usually due to indirect violence (*e. g.* a fall on the hand with the elbow and shoulder-joint rigid, or a fall on the shoulder). Since the clavicle rests on the first rib when the shoulder is fully depressed, it may give way across this bone as a fulcrum in carrying heavy

Fig. 33.—Specimen of united fracture of the right clavicle, seen from above. Callus excessive; the inner fragment is drawn upwards and forwards, and over-rides the outer one.

weights, &c. Incomplete or greenstick fractures are especially common in this position amongst children. The symptoms of the usual form of fracture are very characteristic. Muscular action, as well as the weight of the arm, is of importance in producing the displacement. The sternal fragment tends to be drawn upwards by the cleido-mastoid muscle. The arm is drawn down and towards the chest by the strong muscles (pectorales, &c.), the action of which in this direction is normally opposed by the clavicle acting as a pillar from sternum to shoulder-blade.

Besides the downward and inward displacement the arm and outer fragment undergo a rotation inwards. The treatment of this typical form of fracture can now, as a rule, be carried out, even in the worst cases, with success, in the

Fig. 34.—Fracture of the right clavicle, united with upward and forward displacement of the inner fragment. The shortening of the right clavicle is obvious if a measurement be taken from the middle line of the sternum to the outer border of the shoulder.

Fig. 35.—Recent fracture of the right clavicle, with typical deformity, the long inner fragment projecting upwards, the outer fragment and shoulder depressed.

Fig. 36.—Putting up a fractured clavicle; the assistant draws back

sense of overcoming the deformity. In old times this was regarded as almost impossible. During the application of the apparatus an assistant should stand behind the seated patient, and with both hands should draw the shoulders well backwards (aided perhaps by the assistant's knee). Sayre's method, requiring three bands of strapping, is one of the best that can be used. The first strip is meant to

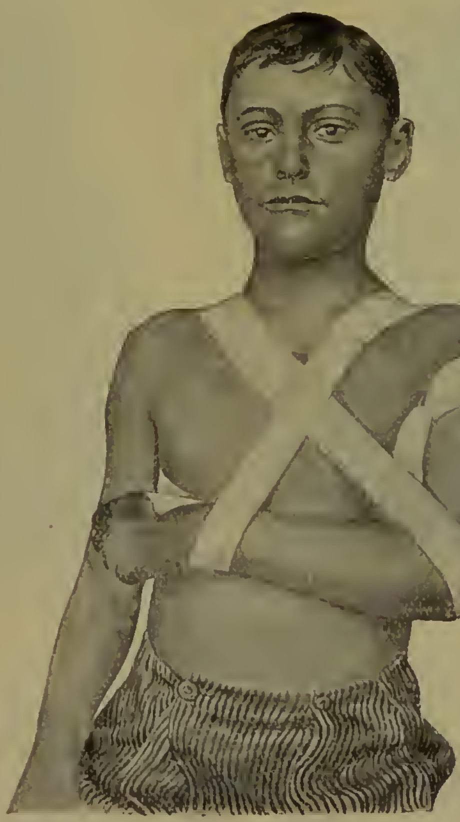


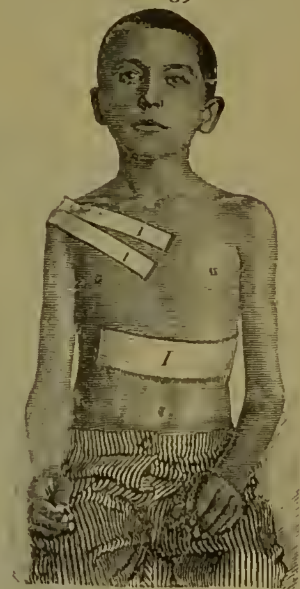
Fig. 37.—The use of Sayre's method in putting up a fractured clavicle.

correct the inward rotation of the arm, passing round the arm from within outwards and so behind the back; the second band raises the sunk arm, passing under the elbow and over the shoulder of the sound side; the third strip supports the forearm and passes over the injured clavicle, exerting slight downward pressure on the inner fragment (see Fig. 37). An axillary pad of moderate size is used,

over which, in summer especially, it is desirable to sprinkle some boracic and starch powder. The whole is carefully bandaged over, and the turns fixed together with stitches. To increase the action of the bands of strapping, pieces of india-rubber band may be inserted, as shown in Fig. 38, so as to exert constant traction.

Fig. 38.

Fig. 39.



Figs. 38 and 39.—The use of bands of strapping, with intercalated pieces of rubber webbing.

Properly applied, and with due oversight of the patient, this method may be trusted to give excellent results in fractures of the clavicle, and it is to be regretted that so many indifferent ones are met with. Amongst the complications we have primary injury to the brachial plexus, or secondary trouble from pressure due to callus,[1] or less com-

[1] Sir Robert Peel died from fractured clavicle producing a wound of the subclavian vein.

The amount of callus produced after a fracture of the clavicle is sometimes extravagant. I have seen more than one case in which it gave rise to the suspicion of tumour, and in the London Hospital Museum there is a specimen from a case in which the whole clavicle was actually excised for this reason.

The patient from whom it was obtained presented himself as an out-patient at the London Hospital with a painful tumour on the right

PLATE XXIII.

FRACTURE OF THE CLAVICLE, WITH TYPICAL DISPLACEMENT.

The site of fracture is at the junction of the inner and middle thirds of the bone. The inner fragment appears to be drawn upwards by the contraction of the cleido-mastoid muscle, or pushed in the same direction by the outer fragment. The great pectoral muscle has been partly removed, and the axillary space (considerably narrowed by the dislocated head of the humerus) is thus exposed. The shoulder and arm are depressed.

monly injury to the subclavian vessels. Damage to the pleura or summit of the lung by a sharp fragment of the clavicle is

Fig. 40.—Right clavicle seen from behind. Oblique fracture through the sternal third firmly united by callus.

Fig. 41.—United fracture of the acromial end of the right clavicle, seen from in front. The smaller fragment is directed obliquely upwards; the two fragments impinge against each other like the rafters of a roof.

excessively rare. Fracture of the acromial end of the clavicle is sometimes accompanied by marked displacement (see Fig. 41), and may offer considerable difficulty in the treatment.

clavicle. As he denied having met with an accident, he was at first treated on the supposition that it might be of syphilitic origin. There being no improvement he was admitted as an in-patient. Crepitus was discovered, and the possibility of ordinary fracture from violence having been excluded by the persistent statement of the patient, it was after consultation decided to remove the clavicle as probably the seat of malignant disease. The operation was performed by Mr. John Couper in 1886, and section of the bone disclosed the true character of the tumour. The man returned to the hospital in 1872, and had quite as good use of the right as of the left upper extremity.

A similar excessive formation of callus around a simple fracture (without perhaps material displacement) has been known to occur in the case of other long bones, particularly the femur and tibia, and amputation of the limb has been resorted to in the belief that a steadily growing sarcoma was present. Only elaborate microscopical research can sometimes decide the question.

Fracture of the clavicle may fail to unite by bone; and the movements of the fragments may so irritate the cords of the brachial plexus as to produce a condition allied to writers' cramp on any attempt to use the hand. Mr. A. E. Barker has recorded a case of this in which the symptoms were completely relieved by wiring the fracture.—J. H.

Fig. 42.—Recent fracture of the acromial end of the clavicle. The left normal clavicle measures 18 cm., the right one 16 cm., showing that the acromial fragment is only 2 cm. long. The latter projects strongly upwards, and is already united with the inner fragment, which is obliquely displaced upwards, and the end of which is easily felt under the skin.

Dislocation of the Clavicle.

The dislocation of the sternal end may be in one of three directions—forwards, upwards, and backwards (see Plate XXIV).

The diagnosis is always easy, since the palpation of the displaced bone end will prevent mistake with the sharper point of the fractured bone, and it may be confirmed by measurement of the length.

In the case of dislocation backwards, owing to pressure on the trachea and œsophagus, difficulty in breathing and swallowing may be present. The re-position is usually easy, the retention in good position difficult. Bands of strapping exerting direct pressure on the replaced joint end should be used, combined with elastic traction, and under certain circumstances with the addition of subcutaneous suture.

Dislocation of the Acromial End.

In exact language this should be termed dislocation of the scapula. The clavicle may be displaced upwards or downwards, the latter being of extreme rarity. The former may be said to be complete, when after rupture of the coraco-clavicular ligaments the scapula travels still more downwards. In the diagnosis, which is as a rule easy, care must be taken

Fig. 1

Fig. 1a

Fig. 1b

PLATE XXIV.

DISLOCATION OF THE STERNAL END OF THE CLAVICLE.

Fig. 1.—View from in front of a man aged fifty-seven, with forward dislocation of the right clavicle at its inner end. The right shoulder is slightly approximated towards the middle line.

Fig. 1 *a*.—Dissection of the dislocation represented above.

Fig. 1 *b*.—Backward dislocation of the clavicle, showing how the trachea and œsophagus might be severely compressed.

Fig.1

Fig.1a

Fig.1b

PLATE XXV.

UPWARD DISLOCATION OF THE ACROMIAL END OF THE CLAVICLE.

The abnormal projection of the clavicle on the right side is at once evident, together with the depression of the head of the humerus and the acromion. The latter is still more plainly seen in fig. 1 *b*. Since the action of the clavicle, as a prop or pillar to the scapula, is lost, the arm falls inwards towards the chest, and the axillary cavity is diminished.

Fig. 1 *a* illustrates this displacement on the skeleton.

not to mistake the injury for dislocation of the humerus or a fractured clavicle, and exact measurement of the length of the clavicle, and following the line of the acromion on each side with the fingers, will prevent mistake.

In the treatment the arm must be kept elevated, and the clavicle depressed by means of strapping and elastic bands, and perhaps subcutaneous suture of the ligaments.[1]

Fractures of the Scapula.

These amount in all to only about one per cent. of fractures. Those of the body and spine of the scapula are due to direct violence, often take the form of multiple lines of fracture and fissures (see Plate XXVI), and crepitation and abnormal mobility can frequently be distinguished. The treatment consists in keeping the affected arm and shoulder at rest, and light pressure with a bandage. Fractures of the neck of the scapula inside the coracoid process, and sometimes starting from the supra-scapular notch, although very rare, are of importance, since they may be mistaken for subcoracoid dislocation of the humerus.

A prominent symptom is sinking of the arm, which may be somewhat abducted, with projection of the acromion; the deformity can, however, be made to disappear with upward pressure on the arm, when crepitus is felt, and it is reproduced as soon as the pressure is taken off. Sometimes the

[1] A few cases have been recorded in which the clavicle has been dislocated at both ends, the inner end forwards and downwards, the outer end backwards and upwards into the posterior triangle. The ligaments must be very extensively torn, since the bone is described as being directed almost at right angles to its normal position (see 'Brit. Med. Journ.,' Oct. 26th, 1896, and 'Gaz. des Hôp.,' 1859). It may be noted that besides the two directions in which the author describes the acromial end as being displaced, viz. upwards and downwards, a direct backward dislocation appears sometimes to occur. Davis ('Annals of Surg.') describes a case and refers to several others. In any of the forms of dislocation at the acromio-clavicular joint, if much difficulty is found in retaining the bones in position, it may be justifiable to secure them together by wire suture. Poirier and others have recorded cases where this has been done with success; and although it can be but rarely required, the method is much more likely to attain its end than the "subcutaneous suture of ligaments" referred to by Professor Helferich.—J. H.

edge of the fracture can be felt through the axilla. In the treatment the arm must be kept elevated, and pressed somewhat outwards and backwards, the whole arm and scapula being kept at rest by the use of Sayre's method for the treatment of fractured clavicle.

Fig. 43.—Detachment (partial) of part of the glenoid fossa.

Fracture of the edge of the glenoid cavity (rare) produces slight sinking of the head of the humerus when the latter is abducted to the horizontal position, whilst crepitus may be felt on movement of the shoulder. Isolated fracture of the coracoid process (from direct violence) is excessively rare; a similar fracture of the acromion more common.

Dislocations of the Shoulder.

These form some of the most frequent and important of all injuries; their diagnosis is, as a rule, not difficult, but yet many cases escape recognition. On palpation of the normal shoulder one feels the projection of the acromion below, and to the inner side of it the coracoid process, the head of the humerus covered by the deltoid muscle, but yet so distinctly that the two tuberosities and the bicipital groove can be distinguished on rotation. Through the axilla the head of the humerus and the border of the glenoid fossa can be recognised. As is well known, the humerus is not held in position by the capsule so much as by muscular contraction and by atmospheric pressure. In paralysis of the deltoid muscle the head of the humerus always sinks down

somewhat, and there are cases of infantile paralysis of this muscle in which, from the thinness of the soft parts, this depression of the bone can be at once seen.

Forward Dislocation of the Humerus.

This form, either pre-glenoid, subcoracoid, or subclavicular, according to the degree of displacement of the humeral head, is the commonest dislocation of the shoulder. On the dead subject it may be produced fairly easily by a gradual but vigorous backward pressure of the much-abducted arm; by these means the capsule is strongly stretched over the head of the bone, it gives way on the inner side, and the humerus passes through the rent under the coracoid process. When the arm is brought down the typical symptoms of the dislocation are obvious (with the exception of the extravasation). On the living subject the dislocation occurs through direct pressure acting from behind and the outer side, more frequently from indirect violence from a fall on the hand, the elbow, or the arm, particularly when the latter is directed backwards. It may also be due to sudden muscular action in throwing, &c. In strong abduction of the arm the surgical neck of the bone of the humerus comes in contact with the acromion and upper edge of the glenoid fossa, which form a fulcrum, and the short arm of the lever is pressed out of its normal position. As a rule the dislocation is at first a subglenoid one, but from muscular action becomes almost at once subcoracoid. As regards the anatomical conditions, the head of the humerus rests directly on the inner border of the glenoid fossa [1] (see Fig.

[1] In most specimens obtained from cases of old unreduced dislocation of the humerus a more or less deep groove at the back of its head will be found. This groove in some cases is so sharply cut as to suggest the use of a chisel. It is probable that this grooving is present as a rule in the examples of recurring dislocation, and facilitates re-dislocation. The excavation is always due to wearing of the bone against the glenoid edge, though a slight indentation (which Mr. Caird has shown is of frequent occurrence in ordinary cases of subcoracoid dislocation) between the head and the great tuberosity may be due to a kind of impacted fracture at the time of injury. It is, however, quite a mistake to assert, as has been recently done, that this excavation is invariable in subcoracoid dislocation. In Sir Wm.

44). In a subclavicular dislocation the head is moved still further inwards, whereby the axillary vessels and nerves are likely to be severely compressed.

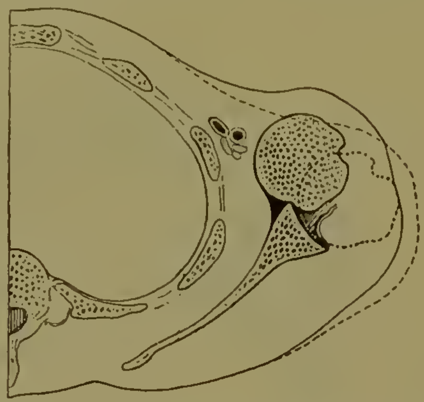


Fig. 44.—Horizontal section through the shoulder and thorax in a case of subcoracoid dislocation on the right side. The normal position of the humeral head is indicated by a dotted line. The relation of the displaced head to the axillary vessels and nerves is also shown. (After Anger.)

The symptoms of a typical subcoracoid dislocation are very characteristic (see Plate XXVII), depending on the two facts that the head of the bone is absent from its normal position, and present in an abnormal one. It is necessary always to begin with a careful inspection of both shoulders, and this alone is often sufficient for the diagnosis, so that palpation is only required to confirm this. The best position for the patient is to sit with both shoulders exposed, on a chair opposite to the surgeon, the arm on the sound side being placed in a corresponding position to that of the dislocated one. There is sinking of the shoulder, the acromion process forming a projecting angle. Below the coracoid process an abnormal projection can be seen and felt, and is made more distinct by attempting the rotation of the arm. The arm is slightly abducted, with strong pressure the elbow can be made to touch the side, but it springs out again directly the pressure is removed. This symptom is due to

Flower's forty-one recorded dissections of old unreduced shoulder dislocations ('Path. Soc. Trans.,' 1861, p. 189) in at least seven there was no groove whatever.—J. H.

Fig. 1

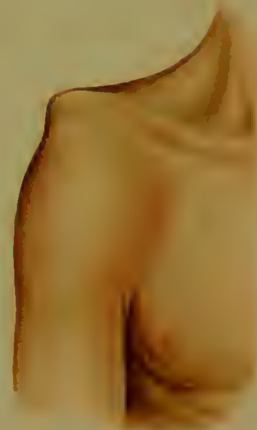


Fig. 1a

Fig. 2

Fig. 2a

Lith.Anst v F Reichhold, München

PLATE XXVI.

FRACTURES OF THE SCAPULA.

Fig. 1.—Dissection of fracture of the neck, the outer fragment including the glenoid fossa and coracoid process.

Fig. 1 *a* represents this condition on the living subject; the projecting acromion and depression of the shoulder are well shown.

Figs. 2 and 2 *a*.—Specimen of multiple fracture of the spine and body of the scapula.

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PLATE XXVII.

SUBCORACOID DISLOCATION OF THE HUMERUS.

From a man aged sixty-four, who had sustained the injury three weeks previously. During this time the swelling had gone down, and the relation of the shoulder-joint had become easily recognised. The acromion projects markedly; the outer contour of the abducted arm shows an angle; the axis of the arm is directed towards the coracoid process instead of towards the acromion; there is fulness under the coracoid process; the length of the arm appears to be increased.

the stretching of the coraco-humeral ligament and the muscles inserted into the tuberosities. The axis of the arm

Fig. 45.—Subcoracoid dislocation of the right arm. The axis of the humerus on both sides is shown by a black line.

is directed towards the coracoid process instead of towards the acromion. The outer border of the arm forms an angle at its centre (for explanation of this see Plate XXVIII), the arm appears to be lengthened, and the actual measurement from the acromion to the external epicondyle is as a matter of fact often increased, at any rate never diminished.[1] The explanation of this fact lies in the position of the head somewhat below its normal place in the glenoid fossa. The head of the bone can be more or less plainly felt through the axilla; passive movements are limited and very painful, and active ones still more diminished. Amongst the complications we may notice detachment of part of the great tuberosity, sometimes damage to the brachial plexus, much more rarely to the axillary vessels. The nerve-trunks are always stretched, and sometimes squeezed between the side of the thorax and the humeral head (see Plate XXIX). The

[1] In comparing the length of an injured limb with that on the apparently sound side it must not be forgotten that the latter may have been formerly injured. Thus, in a case under my observation, one of dislocation of the right humerus, there was apparently three quarters of an inch lengthening on this side, but the difference remained the same after reduction, and was found to be due to an old fracture of the left humerus.—J. H.

circumflex nerve is sometimes paralysed, and on this account it is best, after reduction of the dislocation, to test the action of the deltoid in order not to make an error in the prognosis.

Figs. 46 to 49 illustrate the differential diagnosis of subcoracoid dislocation of the humerus. In each the letter *a* indicates the acromion.

FIG. 46.

FIG. 47.

FIG. 48.

FIG. 49.

Fig. 46.—Upward dislocation of the clavicle at its acromial end.
Fig. 47.—Typical subcoracoid dislocation of the humerus.
Fig. 48.—Fracture of the neck of the scapula, with flattening of the deltoid.
Fig. 49.—Fracture of the neck of the humerus with abduction of the arm.

With regard to the differential diagnosis we may note the following conditions which may be the cause of mistake.

1st. Severe contusion of the shoulder.

2nd. Dislocation upwards of the clavicle. In this the

Fig. 1

Fig. 2

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PLATE XXVIII.

SUBCORACOID DISLOCATION OF THE HUMERUS.

Fig. 1 shows how the head of the bone lies deeper than normal, and hence how the appearance of lengthening of the arm is produced.

Fig. 2 shows the stretching of the middle fibres of the deltoid, the border of which forms an angle with the axis of the arm which has been already noticed—an angle open externally.

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PLATE XXIX.

DISSECTION OF A SUBCORACOID DISLOCATION.

This plate shows a further stage in the dissection of the specimen figured, Plate XXVIII. The front part of the deltoid muscle has been separated from the clavicle and turned outwards, so that the tense middle fibres of the muscle are seen from within. Part of the pectoralis major has been cut away, and the coracoid process is shown with the attachments of the pectoralis minor, coraco-brachialis, and short head of the biceps.

Below the coracoid process the head of the humerus is shown with its cartilaginous surface projecting through a rent in the capsule ; the tense supra-spinatus, infra-spinatus, and the teres minor are seen at their insertions. The axillary nerves lie immediately to the inner side of the displaced head.

On the outer side of the surgical neck, between it and the deltoid, is a cavity which has been enlarged by the removal of fatty tissue, and through which runs the circumflex nerve.

angular projection is formed by the extremity of the clavicle, not of the acromion; the arm is not abducted, the deltoid is not flattened.

3rd. Fracture of the neck of the scapula. In this condition the acromion projects, the head of the humerus sinks downwards and somewhat inwards, but simple upward pressure of the arm removes the deformity, whilst crepitus is generally felt.

4th. Paralysis of the deltoid muscle leads to sinking of the arm, which is less evident on upward pressure. The arm is not abducted.

Fig. 50.—A simple apparatus for keeping the arm at rest after reduction of a dislocation of the humerus.

5th. Fracture of the acromion with much displacement of the outer fragment; in this the relation between the acromion and the head of the bone remains unchanged.

6th. Fracture of the neck of the humerus; in this the projection of the humeral head is still present, even when the upper end of the shaft is displaced inwards and the arm abducted The arm is never increased in length, but almost always shortened.

Treatment.—The immediate re-position must be carried out. Often it succeeds without anæsthesia, though frequently the

latter is required. Of the many different methods of reduction the following are here recommended :—(A) Extension of the slightly abducted arm by means of an assistant, whilst contra-extension is obtained by means of a broad towel passed round the chest; the surgeon manipulates the head of the bone, pressing it in the direction of the glenoid fossa.

(B) *Sir Astley Cooper's method*, consisting in traction on the arm in the line of the trunk, with the foot serving as a fulcrum in the axilla, or (C) extension in the strongly abducted position of the arm whilst direct pressure is made on the head of the bone.

(D) *Kocher's Manipulation Method.*—This consists in a series of movements which should be carefully and exactly followed (see Plate XXX). They follow each other, and consist in—

1st. Adduction of the arm until the elbow touches the trunk.

2nd. Rotation outwards with the elbow bent until marked resistance is felt (this must be done gently for fear of fracture) ; in this way the head of the humerus moves outwards from the coracoid towards the acromion process.

3rd. The adducted and outward rotated arm is now drawn forwards and upwards ; the head begins to pass through the rent in the capsule and return to its normal place.

4th. Inward rotation by which the head of the bone is completely replaced without any jerk, and so lightly that one often does not notice the moment of reduction, and first makes sure of this by examination. With this method reduction often succeeds without anæsthesia. During the adduction of the arm the upper part of the capsule is stretched and the head pressed against the glenoid edge, so that the later rotation turns it on the latter, and not round its own axis. When the arm is elevated the coraco-humeral ligament becomes relaxed. The success of the reduction makes itself known by a more or less evident click, and particularly by the return of the normal movement and contour. In the after-treatment the hand is kept over the sound shoulder by means of strapping or bandage. After eight days passive movements should be begun, a little later active ones. The total duration of the treatment up to the time when the

Fig. 1

Fig. 2

Fig. 3

Fig. 4

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PLATE XXX.

ILLUSTRATING THE METHOD OF REDUCTION KNOWN AS KOCHER'S.

In preparing these drawings the specimen shown in Plates XXVIII and XXIX was used, and photographs made at each stage of the reduction.

Fig. 1.—The arm is adducted until the elbow touches the side of the chest; no marked difference is seen in the position of the head.

Fig. 2.—The still adducted humerus is fully rotated outwards by means of the flexed forearm; the rent in the capsule is more plainly seen; the head is now nearer the acromion, and further from the brachial plexus.

Fig. 3.—Whilst retaining the adduction and outward rotation, the arm is now fully elevated (brought forwards); and in fig. 4, by rotation inwards, the complete reduction is effected.

Modifications and Complications.

If the head leaves the joint cavity directly forwards it lies between the scapula and the subscapularis muscle, so close to the glenoid fossa that its edge touches the articular cartilage ; in these cases, which especially result from direct violence, within a few weeks the opposed bone surfaces become reciprocally worn down, and this goes on increasing, so that a deep groove is produced in the head of the humerus, whilst the front portion of the glenoid cavity disappears and a new articulation is formed. Reduction in such cases is very difficult, and may be impossible without arthrotomy.[1]

humerus may take place although the head of the bone does not come through any rent in the capsule, and one of the following three conditions will then probably be present to produce it:

1. Fracture of the anterior edge of the glenoid fossa, which if it unites by bone does so in a displaced position, so as to render the glenoid cavity narrower and more shelving.

2. Separation of the capsule and periosteum in one piece from the neck of the scapula. This has been clearly demonstrated by French writers (see Duplay and Reclus, 'Traité de Chirurgie'). The edge of the glenoid fossa then gradually wears down as the dislocation recurs, until at last it may be difficult to prevent the humerus from continually slipping out.

3. Fracture of the coracoid process, when the symptoms of dislocation with crepitus on reduction, which is effected by slight pressure only, are present (see report of case and dissection by J. F. South, 'Med.-Chir. Trans.,' vol. xxii, p. 100).—J. H.

[1] How long after the accident may reduction of the dislocation be safely attempted? It is really impossible to lay down a binding rule on this point. There are two chief dangers to be thought of in old-standing cases. Efforts at reduction (and especially those involving strong abduction of the arm from the trunk, sudden jerky movements of the arm in manipulation, &c.) may cause fracture of the humerus or rupture of one or more of the axillary vessels. There are other minor dangers, such as the production of extensive bruising, tear of muscles, and possibly exciting the changes of osteo-arthritis. The older the subject the greater the chance that the vessels, if not atheromatous, will have lost their normal elasticity, and therefore be more liable to rupture. That the surgical neck or shaft of the humerus may give way is also more likely in advanced life. Hence, if the patient is past the prime of life, the surgeon must be the less inclined to advise reduction even within reasonable lapse of time since the dislocation, *i. e.* from four to six weeks. It is true that breaking down adhesions by moderate manipulation may improve the range of movement, even though reduction be not effected ; but if the humerus is broken in forcible endea-

Fig. 1

Fig. 2

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PLATE XXXI.

OLD SUBCORACOID DISLOCATION. FORMATION OF A NEW GLENOID CAVITY. WEARING AWAY OF THE HEAD OF THE HUMERUS. (Compare the horizontal section in Fig. 44.)

Fig. 1 shows the two bones seen from in front. The head of the humerus conceals the glenoid fossa, and articulates with the neck of the scapula immediately below the coracoid process, where there is a ridge of new bone formed. The humerus remains somewhat abducted, and the mobility of the new joint is extremely slight.

Fig. 2.—The same specimen, showing the back of the humeral head worn away. The eburnation of both bones which was present cannot unfortunately be seen in the illustration.

Fig.1 Fig.2

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PLATE XXXII.

FRACTURE OF THE SURGICAL NECK OF THE HUMERUS.

Fig. 1.—A dissection in which parts of the deltoid and pectoralis major and minor have been removed in order to expose the fractured bone, &c. It will be seen that the shaft is displaced inwards, and endangers by its projection the axillary vessels and nerves. The long head of the biceps is twisted and displaced.

Fig. 2.—An old severe fracture of the surgical neck, which implicated also the tuberosities and the anatomical neck. The upper end of the shaft is displaced upwards and inwards, and is united to the rest of the bone by much spongy callus.

Supra-coracoid dislocation, extremely rare, is always associated with fracture of the coracoid process. Dislocation with

vours at replacement (and this certainly happens much more often than one would suppose from printed records) the patient is left considerably worse than before, whilst if the axillary vessels be torn the danger to life is something like 70 per cent. Great difficulty may be found in effecting reduction at the end of even three or four weeks, whilst it is rarely possible without incision after six to eight weeks have elapsed. But this is only a general statement, and some remarkable exceptions where reduction has been secured at the end of four to six months have been put on record. Taking, then, six to eight weeks as being roughly the limit at which the surgeon's efforts (without operation) are likely to be successful, we may again emphasise the necessity for avoiding sudden and forcible abduction on account of the risk both to the bone and to the axillary vessels.

The patient being fully anæsthetised the arm should be worked gently in all directions in order to break down adhesions, and then Kocher's method and traction with the arm moderately abducted should be alternately tried.

Malgaigne, Körte, Callender, and Stimson have collected series of cases in which the axillary artery or vein, or the subscapular or other large branch of the axillary artery, have been damaged during efforts at reduction, and with the proviso that in a few of these the damage may have been done at the time of the dislocation, we have upwards of fifty cases from which to draw conclusions.

1. Whilst some of the patients were old (in Sands' case eighty-four years, in Callender's sixty-one, in Hailey's fifty-nine), nevertheless a considerable portion were subjects under thirty, whose vessels must have been perfectly healthy.

2. The axillary artery is far more likely to be torn than the vein, though the absence or cessation of pulsation in the axillary swelling, which first draws attention to the injury, is not conclusive evidence as to the implication of the artery.

3. Spontaneous cure is possible, but would seem to have occurred in only six out of thirty-two cases.

4. Should this unfortunate accident occur, the best treatment would appear to be immediate ligature of the third part of the subclavian artery, unless there is strong reason to think that it is the vein or a branch of the artery only that is involved. To make an incision into the axilla, to clear out the blood, and to find and tie the bleeding vessel *in situ* would appear theoretically to be the right course, but it has the grave drawback that all the recorded cases have been fatal (see valuable paper by Lord Lister, 'Brit. Med. Journ.,' January 4th, 1890, which gives the results of two cases of old dislocation operated on by open incision, division of adhesions, &c.). In his fatal case of rupture of the axillary artery (dislocation unreduced for eight weeks) it was found at the post-mortem that the artery had been fixed to the coracoid process and to the head of the humerus by a firm fibrous band of new formation. Many surgeons have recorded successful cases of

simultaneous fracture of the neck of the humerus is a very severe injury. If reduction fails with the aid of direct manipulation an incision should be made, and if the loose fragment is small and chiefly intra-articular, it should be removed. Formerly it was advised to make a false joint at the side of fracture, whilst leaving the head in its displaced position.

Downward Dislocation of the Humerus.

In this form the head rests on the lower border of the glenoid fossa, and is easily felt from the axilla; the arm is

Fig. 51.—Horizontal section showing a subspinous dislocation of the humerus (compare Fig. 44).

raised nearly horizontally from the side, the deltoid is markedly flattened, the acromion projects, the glenoid fossa is empty, and the functions of the joint are lost. Sometimes the arm is strongly elevated (Luxatio erecta), reduction suc-

operation on old unreduced subcoracoid dislocation. With regard to this procedure it may be noted that—1st. Even with free exposure of the part by the ordinary excision wound it may be very difficult to make out the exact obstacle to reduction, and to divide it. The use of pulleys may be of great assistance. 2nd. Excision of the head of the bone sometimes gives the best result, especially when the dislocation is of very old standing. 3rd. No such operation is justifiable unless the patient is otherwise in thoroughly good condition, and unless there is no prospect of a fair range of mobility and usefulness of the arm being recovered.—J. H.

ceeds with traction on the arm, and direct pressure on the head from the axilla.

Backward dislocation (subacromial or subspinous) is very rare, and occurs chiefly from direct violence. The head of the bone is readily seen and felt in its abnormal position; the coracoid process projects in front.[1]

Reduction is effected by traction on the arm when abducted, and direct pressure.

Fractures of the Humerus.

A. *Fractures of the upper end.*—The bone may break through the anatomical or surgical neck, but more commonly the line of fracture does not exactly follow either. Direct violence may produce it from a blow or fall on the outer side of the shoulder, or the fracture may be indirect owing to a fall on the elbow pressing the head of the bone against the glenoid fossa or acromial vault. The diagnosis of these fractures is always difficult, and when there is much extravasation it is extremely so. Besides carefully noting the direction of the humeral shaft, and any alteration in the contour of the shoulder, careful digital examination should be made, both from the outer side and from the axilla. Normally the tuberosities, the bicipital groove, and the surgical neck, are easily to be felt, not however the anatomical neck or the cartilage-covered head. Fracture through the anatomical neck, strictly speaking, is very rare. If the articular part of the head were alone broken off wholly within the capsule its vitality would be in question; it might be compared to a loose body detached by violence in the knee-joint. As a rule this fracture is, however, not purely intra-capsular; the fragment is nourished through bands of capsule, and the line of fracture runs through the adjoining tuberosities or upper end of the shaft. Impaction may easily happen,

[1] In the case of an epileptic patient the humerus was displaced under the spine of the scapula during a fit. In spite of the conspicuous deformity no attempt at reduction had been made, and when the patient came under observation six months later the arm was much wasted even to the fingers, and was almost useless. There was nearly three quarters of an inch lengthening of the arm, which was practically rigid at the shoulder.—J. H.

the displacement is as a rule but slight, but the loose fragment has been known to be turned completely round, so that its cartilaginous surface faced the shaft.

FIG. 52.

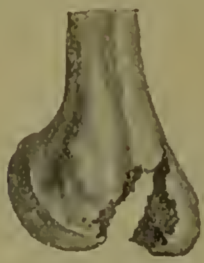

FIG. 53.

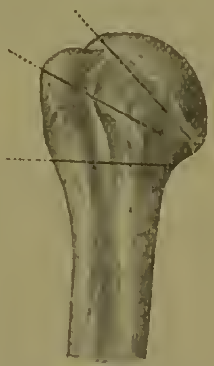

Fig. 52.—Fracture of the great tuberosity of the right humerus.
Fig. 53.—The upper end of the humerus, showing possible lines of fracture.

Fig. 54.—Axillary pad made out of wood-wool encased in gauze, and retained in position by a bandage.

The symptoms are those of a severe traumatic lesion of the shoulder-joint. Only under an anæsthetic can the fracture be made out, owing to abnormal mobility and crepitus. There will, of course, be marked loss of function and pain.

Treatment.—With the patient in bed, weight extension is applied to the arm; subsequently an axillary pad is used, and passive motion is commenced early.

B. *Fracture through the surgical neck* (see Plate XXXIII, fig. 2) is a fairly common injury. The bone breaks below the tuberosities, or the shaft is impacted into the latter. The

Fig. 55.—Separation of the left upper epiphysis of the humerus in a girl aged fifteen, who had fallen directly on to the shoulder from a considerable height fourteen days before admission to the hospital. The upper end of the diaphysis is displaced forwards and inwards, and its axis directed in front of the acromion.

Fig. 56.—Shows the thickening on the pectoral aspect due to the displacement of the diaphysis. An incision was made on the front of the joint (as for resection); the diaphysis, which was completely displaced, was returned into position, and fixed by means of a steel needle. Union resulted with good movement in the shoulder.

fracture is usually due to direct violence from a fall on to the shoulder, but occasionally from one on to the elbow or hand. The upper fragment remains partly under the influence of the muscles inserted into the tuberosities. It is of importance alike for the diagnosis and the treatment to make out whether the shaft is driven inwards or outwards. In one case the axis of the humerus is directed towards the coracoid process or the clavicle, in the other the arm is adducted. The first is much the more frequent. When

Fig. 57.

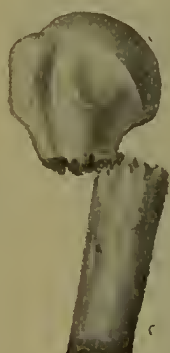

Fig. 58.

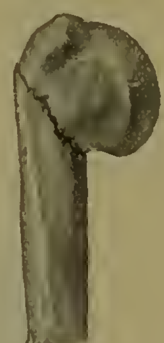

Fig. 57.—Fracture of the surgical neck. The shaft is displaced inwards and abducted.

Fig. 58.—Fracture of the surgical neck. The shaft is displaced outwards and driven into the head.

this has occurred the arm is, as a rule, shortened and slightly abducted. There is abnormal mobility as a rule if the head of the bone be well fixed, and if there is much displacement the upper end of the shaft may be felt under the pectoralis major and skin. It must be remembered that a dislocation may be combined with the fracture.

Treatment.—Careful reduction of the displacement under an anæsthetic is indicated; and weight extension, either with the patient in bed or going about (see Figs. 60, 61, and 62), should be employed.

Counter-extension is advisable; an axillary pad may, as a rule, be dispensed with. Careful passive motion should be begun as soon as possible. Fracture through the tuberosities is, as a rule, due to a fall or blow on the outer side of the

Fig. 3

Fig. 2

Fig. 1

Fig. 4a

Fig. 4

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PLATE XXXIII.

FRACTURES OF THE UPPER END OF THE HUMERUS.

Fig. 1.—Vertical section of a normal bone from a young adult, showing the epiphysial line.

Fig. 2.—Separation of the upper epiphysis; the specimen is seen from behind and the outer side. The diaphysis is displaced forwards and inwards. (*Translator's note.*—It is obvious that this is a mistake in description, since the line of fracture in no part follows that of the epiphysial junction.)

Fig. 3.—Specimen showing an old united fracture, the upper fragment being somewhat abducted and the shaft adducted, so that the two are united at a right angle. There was probably some impaction, and there is much callus formed.

Fig. 4.—Case of fracture through the surgical neck in a man aged twenty-two. The shaft is displaced forwards and inwards, as will be seen by comparison of its axis with that of a normal humerus shown in fig. 4 *a*.

shoulder. Impaction may be present. The treatment is on the same principles as for fracture of the surgical neck.

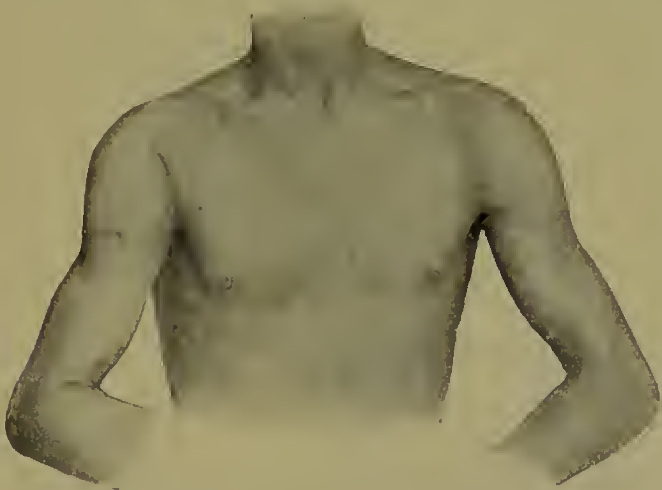

Fig. 59.—Fracture of the surgical neck on the right side. The skin is puckered owing to the pointed end of the shaft. The arm is abducted and shortened. The patient was aged twenty. Complete reposition was effected under an anæsthetic.

c. *Traumatic separation of the upper epiphysis of the humerus* (see Plates XXXIII and XXXIV).—This injury on account of its comparative frequency is of practical importance, and may be due to a fall, either on the shoulder or the arm. The symptoms of this lesion are often quite characteristic; the head of the bone remains in position, and the

Fig. 60.—Weight extension applied to the arm with counter-extension to the thorax, lateral traction being made also on the upper arm by means of a weight.

shoulder is therefore not flattened; the end of the diaphysis may project forwards and inwards, presenting a circumscribed

Fig. 61.—Weight extension applied with the elbow bent.

Fig. 62.—Weight extension applied in a case of fracture of the neck of the humerus whilst the patient gets about.

almost angular prominence, noticeable when one looks at the patient from the side or from above (see Figs. 55 and 56). Abnormal mobility, and perhaps a soft (cartilaginous) crepitus may be noticed on reduction. The latter may be found ex-

Fig. 1

Fig. 2

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PLATE XXXIV.

SEPARATION OF THE UPPER EPIPHYSIS OF THE HUMERUS.

Fig. 1.—Dissection showing the epiphysis still retained in place by the capsule, &c. The end of the diaphysis is quite free, whilst bands of periosteum are seen attached to the epiphysis. The coracoid process is not yet united by bone to the scapula.

Fig. 2.—Great impairment of growth in the right humerus from an injury sustained in very early life.

tremely difficult, or even impossible. If reduction is effected the treatment is the same as that for fracture of the surgical neck; if reduction fails under an anæsthetic an incision should be made, and the interposed soft parts, periosteum, &c., disengaged, and the diaphysis thus returned into place. I have known of several cases of this kind in which after reduction a long steel needle was used for fixation with the best results. If incomplete replacement is obtained probably the growth of the bone will be much interfered with, and it is therefore most important to overcome the displacement. Weight extension and a good axillary pad may be useful after reduction.

We sometimes observe detachment of this epiphysis in newly born children, resulting from injury at the time of birth; in such cases the upper epiphysis (head and tuberosities) may be strongly rotated outwards, whilst the diaphysis is rotated inwards. If this condition is not corrected marked loss of mobility will follow.[1]

[1] Analysing the records of sixty-six cases of separation of this epiphysis (thirteen of which were under my own observation), I find six occurring at birth and four during the first year of life. Omitting these, the average age at which the detachment occurred was thirteen years; in no fewer than seventeen was the patient fifteen years old or more. Sufficient evidence exists from post-mortem examination or operation (in all eleven cases) to enable us to say that the separation occurs in probably nearly all of the cases exactly at the epiphysial line. The strong curve of the latter, due to the upward projection of the top of the diaphysis about its centre, is of practical interest. An American surgeon named Moore claimed that when the diaphysis is displaced it hitches (so to speak) against the outer and under part of the epiphysis; hence the difficulty in reduction, to be met by a manœuvre dignified by the name of "Moore's method," which simply consists in carrying the humerus forwards and upwards, then making slight extension whilst the arm is brought down to the side, and there fixed. Moore regards this locking of diaphysis and epiphysis as of constant occurrence, and that "no plan of treatment" (except his own) "is likely to succeed." The whole contention is a fallacy. In the case of displacement of the diaphysis, here, as in other parts of the body, the main difficulty in reduction, if any exists, is due chiefly to interposition of soft parts, and especially of the tense periosteal sheath, through which the expanding end of the diaphysis has been driven.

The following are the chief points in the diagnosis of separation of this epiphysis:

1. The age of the patient—under about twenty years.

D. *Isolated fracture of one or other tuberosity.*—That of the great tuberosity is sometimes observed as a complication

2. The arm is comparatively helpless, the elbow often directed a little outwards or backwards.

3. Abnormal mobility just below the shoulder-joint, best made out by abducting the humerus.

4. Rapid swelling about the shoulder; some shortening if the diaphysis is wholly displaced.

5. Muffled crepitus on replacement.

Dislocation was wrongly diagnosed in at least 50 per cent. of the recorded cases; a thorough examination under an anæsthetic is important. If once brought fairly back under the epiphysis the sinuous nature of the junction will tend to keep the diaphysis in place. Steady traction on the arm, slight abduction, aided by rotary movement or by direct pressure, is the most likely to attain this end. There is probably no harm in trying "Moore's method," provided that no violent jerking movement is allowed. What should be done if the diaphysis protrudes just under the skin, and prolonged efforts at reduction fail? Here (with every precaution as to asepsis), as the author recommends, the end of the diaphysis should be exposed, the opening in the periosteal sheath enlarged, or the rent in the other soft tissues held open and the bone returned to place. This has been done with success even at an interval of several weeks from the accident, but it is then usually necessary to resect part of the diaphysis. The same course should be followed in the cases of compound separation, where the diaphysis protrudes through the skin. In five such cases resection of the diaphysial end was performed and the bone returned to place, all ultimately recovering with a very useful arm. In two reduction was obtained without resection, but in one of these two inches of the bone subsequently necrosed.

Amongst the rarer complications we have to note injurious pressure on the axillary artery or plexus of nerves, the former in two cases—Clark's and Hamilton's—having caused gangrene of the whole arm. Suppuration is exceptional in the non-compound cases, and should rarely occur after reduction of the compound ones; but it has more than once led to the death of the patient. Noting also that bony ankylosis of the shoulder, from some cause difficult to explain, followed in four of my collected cases—in one suppuration had occurred—we come finally to the important question of arrest of growth in the humerus, and even in the whole arm (with or without paralysis), following detachment of this epiphysis. Striking examples have been published by Bryant, P. Vogt, Bruns, and Humphry. In this case, as in practically every one where the arm has been more or less paralysed and non-developed, the accident which was to blame occurred at a very early age. Whether the brachial plexus is torn as well as pressed on by the displaced diaphysis in these cases we cannot at present decide.

The necessity for thorough examination, correct diagnosis, and gentleness in manipulation in every case of detachment of this epiphysis must be emphasised. Nothing will so certainly be followed by arrest of growth as

of dislocation of the shoulder, and may even result from efforts at reduction, involving strong rotation. Fracture of the lesser tuberosity is much more rare. The symptoms are pain on pressure, loss of function, and a gap at the seat of fracture. The treatment consists in keeping the arm at rest with the fragments as nearly in apposition as possible.

E. *Fractures of the shaft of the humerus* (Plate XXXV).—These may result from direct or indirect violence, and present, in the most obvious way, the usual symptoms—abnormal mobility, crepitus, and displacement of varying degree. If the fracture be below the insertion of the deltoid muscle the upper fragment will tend to be drawn outwards; if towards the junction of the lower and middle thirds the

roughly rubbing the fragments together, even if reduction is effected, and so destroying the delicate epiphysial disc of cartilage.

A very important question arises as to how far an operation is justifiable in a case where the diaphysis has remained partly or wholly displaced, and the patient comes under care some weeks or months after the accident. What bad results have we to expect if nothing is done? First, arrest of growth, since the epiphysial disc almost certainly remains with the epiphysis. But the nearer the subject approaches adult age the less need we think of this. Further, if by operation we replace the diaphysis, it is by no means certain that we can prevent shortening occurring. Secondly, impaired movement at the shoulder-joint, especially in the direction of abduction and rotation. If these are much limited an operation is probably advisable, and still more so if there is evidence of pressure on the axillary vessels or the brachial plexus (both, however, rare). Thirdly, ankylosis of the shoulder. Much will depend on the peculiar circumstances of the case and the operative zeal of the surgeon; but the example of Bruns' two cases and of Smith's is very encouraging in the direction of operation. If the diaphysis remains displaced to a considerable extent a very fair result may in many cases be expected, although shortening will probably occur. This is shown in the cases recorded by Puzey, Hamilton (two), and in one of my own. In all these firm union occurred, and movements at the shoulder-joint were very good. Owing to ossification in the connecting bridge of periosteum, we have little cause to fear non-union between the diaphysis and epiphysis. However, in two cases (both occurring at birth) recorded by Bertrandi and Durocher a false joint appears to have formed.

In recent cases, after reduction care must be taken that the humerus be not rotated on its vertical axis, especially in the inward direction. The epiphysis tends, as already said, to be somewhat abducted, but not to be materially rotated. It is inadvisable to use a bulky axillary pad, and a neatly fitting poroplastic shoulder-cap is one of the best forms of retentive apparatus. Weight extension can but rarely be required.—J. H.

musculo-spiral nerve is apt to suffer, either as a direct result of the injury, or secondarily from pressure of callus, in which it may be deeply embedded. On this account the surgeon should carefully examine for weakness of the extensors of the wrist and hand in order to make no mistake in the prognosis. Union results from correct treatment in a normal manner, but it is to be noted that a false joint is more common in the case of fracture of the humerus than of all the other bones of the upper extremity put together. This is due to difficulty in keeping the fragments at rest, and to the risk of interposition of the soft parts.

Treatment.—If a circular bandage is made to include the upper arm, the shoulder, and the elbow, there is risk of dangerous pressure on the axillary vessels.

Plaster of Paris is sometimes used, but well-padded metal splints (one long splint over the whole length of arm and forearm on outer side, with a shorter one on the inner side) will be found efficient, especially if it is arranged that the bandage shall keep up some extension. The splint is bent so as to receive the semi-flexed elbow, and its upper end is curved over the shoulder so as to be separated from it by a short distance (see Fig. 63) with an efficient pad of

Fig. 63.—A splint for treatment of fracture of the humerus so applied as to keep up traction in the long axis of the bone.

cotton wool in the armpit and bandage; upward traction over the end of the splint is then forcibly made. This apparatus may also be used for fractures of the upper and of the

Fig. 2

Fig. 1

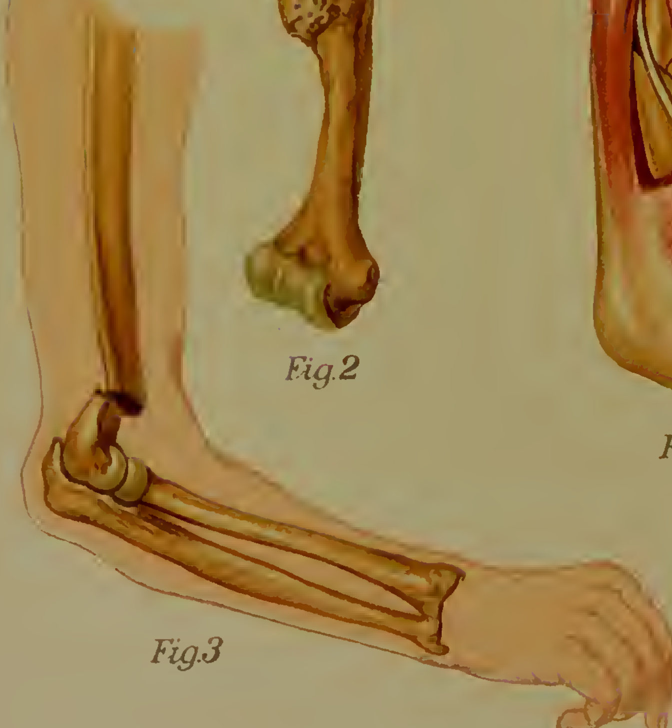

Fig. 3

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PLATE XXXV.

Fig. 1.—Dissection showing a fracture about the junction of the lower and middle thirds of the right humerus (artificially produced, to show the relation of the musculo-spiral nerve to the site of fracture).

Fig. 2.—United fracture with displacement of the shaft of the humerus.

Fig. 3.—Fracture above the epicondyles with typical displacement. simulating backward dislocation of the elbow.

lower ends of the bone. The so-called Middeldorpf's triangular apparatus (see Fig. 64) is much used, and if there

Fig. 64.—Strong metal splint (not padded) applied to a fracture of the humerus; it can be so arranged as to keep the arm abducted to a right angle.

is a marked tendency to reproduction of the displacement strong extension may be required; for this purpose the counter-extension should not be made from the axilla, but from the side of the chest. In such cases it is probably best to confine the patient to bed, when the counter-extension can be readily applied to the thorax, whilst a weight sufficient to maintain proper extension at the seat of fracture is applied to the abducted arm, which rests on a pillow and table close to the bed. Thus any undesirable pressure on the nerves and vessels in the axilla is avoided.

F. *Fracture of the lower end of the humerus.*—Under this heading are included those fractures which occur below the upper part of the origin of the supinator longus.

Their exact diagnosis is often a matter of much difficulty

in spite of thorough palpation. We may note first the normal relations of the bony points, and especially those of the epicondyles (see Figs. 65, 66, and 67) with the

Fig. 65.—The lower end of the humerus. The dotted lines point to the trochlea and capitellum, the internal and external epicondyles, the fossæ for the coronoid process and head of the radius in full flexion.

Fig. 66.

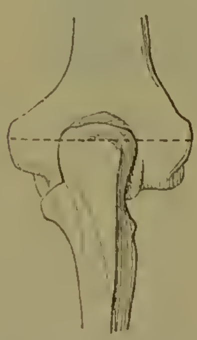

Fig. 67.

Fig. 66.—A line passing between the two epicondyles when the elbow is extended cuts through the olecranon.

Fig. 67.—Lines drawn from the top of the olecranon to either epicondyle when the elbow is bent to form an obtuse angle.

olecranon. When the elbow is fully extended the transverse epicondylar line cuts through the tip of the olecranon. When the elbow is bent to a right angle the three points form a triangle whose plane is vertical (see Fig. 67).

Further, it is most important in making the diagnosis to carefully compare the sound with the injured elbow. Although it is impossible to arrange all cases of fracture of the lower end of the humerus in strict tabular form, the

Fig. 1a

Fig. 2

Fig. 1b

Fig. 3

Fig. 4

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PLATE XXXVI.

Figs. 1 *a* and 1 *b*.—The bones of the right elbow, from a child, who had sustained a severe injury by machinery. The lower epiphysis of the humerus was partially detached, and in addition there is an oblique fracture in the lower third of the shaft, with longitudinal fissure. Longitudinal fracture of the olecranon. Amputation was required.

Fig. 2.—Longitudinal split in the humerus below a comminuted fracture of its centre due to a gun-shot injury. Recovery after amputation.

Fig. 3.—T-fracture of the humerus.

Fig. 4.—Oblique fracture through the elbow-joint, detaching the capitellum and the external epicondyle.

a. Fracture above the epicondyles.

b. Fracture just above the articular eminences.

c. Oblique fracture through the outer part of the joint.

d. Oblique fracture through the inner part of the joint.

e. Isolated fracture of the inner epicondyle.

f. Isolated fracture of the external epicondyle.

g. Intra-articular fracture of the capitellum.

following varieties (illustrated in Figs. 68 and 69) may be distinguished.

Fig. 68.

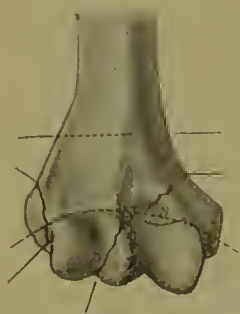

Fig. 69.

Figs. 68 and 69.—Different forms of fracture at the lower end of the humerus.

(*a*) *Fracture of the epicondyles.*—This injury, which is frequently met with in children, generally results from a fall on the elbow or the hand. It may result from, so to speak, over-flexion or over-extension (Figs. 70 and 71); and the displacement, the direction of the line of fracture, and to

Fig. 70.

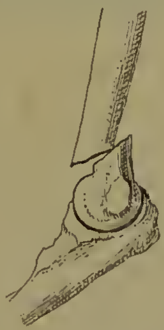

Fig. 71.

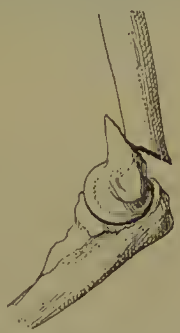

Fig. 70.—Diagram of a fracture of the lower end of the humerus due to hyper-extension. Line of fracture oblique from behind, forwards and downwards.

Fig. 71.—Similar diagram of a fracture from bending of the bone. Line of fracture oblique from in front, downwards and backwards.

some extent the treatment will vary according to which of these two causes has produced the fracture.

Symptoms.—When the fracture has resulted from over-

flexion the lower fragment tends to be displaced forwards, and the sharp end of the diaphysis to be forced into the triceps muscle; in the more common fracture from over-extension the lower fragment is displaced backwards. If the two epicondyles are grasped, and the lower fragment moved, crepitus, or at any rate abnormal mobility, will be made out; further, the forearm can be abnormally ab- and adducted. What displacement exists can be overcome by traction on the bent elbow, but tends to recur directly it is relaxed.

Treatment.—Under full anæsthesia the displacement is reduced, and lateral splints applied, either in the extended or flexed position of the elbow-joint, according to which is found most effective. In adults, if the patient is kept in bed, weight extension applied to the fully supinated forearm (see Fig. 72), with if necessary some lateral traction or direct

Fig. 72.—Treatment by weight extension of a T-fracture into the elbow-joint.

pressure (by a small sand-bag, &c.), will be useful. In children, a similar splint to that shown in Fig. 63 may be employed, but I cannot insist too strongly on the necessity for great care in effecting the first reduction, and in supervising the after treatment. As a rule I employ an anæsthetic when first putting up the fracture, and sometimes even when readjusting the splint, &c., which should not be too long applied, in order that passive movement and massage should be commenced early.

If the treatment is unsuccessful union may result in the position of valgus or varus (see Plate XXXVII).

[One important fact has lately become clear, owing to the use of radiography. The mass of bone which is felt just

Fig. 1

Fig. 1a

Fig. 2

Fig. 2a

PLATE XXXVII.

VALGUS AND VARUS POSITION OF THE ELBOW FOLLOWING FRACTURE OF THE LOWER END OF THE HUMERUS.

Fig. 1 *a*.—Oblique fracture like that shown in fig. 1, which had been produced two years before the drawing was made. Patient a man aged thirty-four. The elbow is in a position of marked valgus.

Fig. 1.—Preparation from a similar case, showing evidence of arthritis deformans, thickening of the head of the radius, &c. The fracture through the lower end of the humerus had been oblique and the capitellum displaced upwards.

Fig. 2.—Cubitus varus following an oblique fracture above the epicondyles which had united with displacement. Arthritis deformans.

Fig. 2 *a*.—Cubitus varus on the living subject, following fracture of the lower end of the humerus.

above the bend of the elbow in so many cases of separated lower epiphysis and the like at the end of treatment, which is put down to excessive callus, and which so much limits the movements of the elbow, is not really callus at all, but the end of the shaft which was originally displaced and never reduced.

The accompanying figures illustrate this well. The first one shows a side view of a separated epiphysis in a boy aged five, taken eight days after the accident. The injury had been carefully treated from the first on a splint, and the displacement was supposed to have been corrected. The skiagraph shows that the diaphysis still projected strongly,

Fig. 73.—Skiagraph of a case of backward displacement of the lower epiphysis of the humerus, showing the usual deformity, taken from a boy aged five, some eight days after the accident. The displacement had been thought to have been reduced, and the arm had been kept in a rectangular splint.

and that the projection would form a permanent obstacle to full flexion. Since it would be denuded in front of its periosteal sheath it would be impossible for the bone here to form excessive callus. On the dead subject I have found

it almost impossible to reduce such displacement as is here shown with manual traction, the elbow-joint being extended; and what applies to manual traction must equally apply to weight extension. The next figure shows the result of as full flexion of the elbow-joint as the swelling would allow; it

Fig. 74.—From the same case as that shown above; by full flexion of the elbow the epiphysis is brought into almost perfect position. This position was kept up for three weeks and an excellent result obtained.

will be seen that the epiphysis has glided into almost perfect position, and there was no difficulty in keeping it there.

Nothing could more clearly illustrate the value of putting up such fractures in the flexed position.—J. H.]

As complications we have to note occasional injury to the ulnar, the musculo-spiral, or the median nerve, which have been known to be torn through; such injury would naturally require careful operative treatment. Sometimes also the brachial artery has been damaged, threatening gangrene of the arm.

(*b*) *Transverse fracture within the joint.*—This form, which

results from a fall on the hand or elbow, is rare, and usually the line of fracture passes partly outside the joint. It includes traumatic detachment of the lower epiphysis (see Plate XLI, fig. 3, and Plate XXXVI, fig. 1 *a*).

The displacement is usually not great; besides the usual signs of fracture there is extravasation into the joint. Examination should be made under an anæsthetic, and after reduction the fracture may be treated either by splints or weight extension, and with the elbow either bent or extended. Early passive motion.

(*c*) (*d*) *Oblique fractures of the lower end of the humerus through the elbow-joint* may break off either the capitellar or the trochlear portion, occasionally both at the same time, and may be accompanied by much displacement of the bones of the forearm. The amount of swelling and pain on examina-

Fig. 75.—Paralysis of extensors of wrist, due to a complicated fracture of the lower end of the humerus; at the elbow a scar is seen over the site of fracture. Patient a boy aged eight.

tion necessitates an anæsthetic for the latter. It is usually possible by testing the lateral movement in extension of the

elbow (ab- and adduction), and by careful comparison with the opposite normal joint, to effect a correct diagnosis. By far the most common form of oblique fracture is one passing downwards from the outer side, and breaking off the capitellum (see Plate XXXVII). It may result from direct violence—fall on the elbow—or indirect, the latter either from a fall on the hand transmitting the force through the radius, or from a fall on the inner part of the elbow with the arm abducted, transmitting the force through the olecranon. This external oblique fracture involves a varying amount of dislocation of the forearm outwards and backwards The piece of bone broken off is often displaced upwards, and perhaps rotated forwards; crepitus, dislocation, and severe pain on passive motion will all be present. The prognosis of this fracture is on the whole not good, for only too easily the displacement may persist, leading to limitation of movement, partly through excessive formation of callus or projection of the fractured portion. It is true that in children and in young subjects, by means of persistent passive and active motion, the amount of movement may be gradually increased; but complete recovery in those cases is almost impossible, and cubitus valgus will probably remain.[1]

Treatment.—Under anæsthesia the displacement must be removed by direct pressure, with the forearm flexed and pronated, and the splints should be so applied as to change the position of the elbow every few days (now full or almost full extension, now flexion). This change of position

[1] One most striking fact about these injuries to the elbow-joint is the frequency with which they are found to be complex or composite lesions,—neither fracture alone nor dislocation alone, but fracture-dislocations. Thus the capitellum may be fractured and displaced upwards, whilst the radius alone or both radius and ulna are dislocated upwards with it; the internal epicondyle fractured with outward dislocation of both forearm bones; the ulna fractured in its upper third, and the radius dislocated at the elbow. These are three well-marked varieties, but several more could be cited. I operated on a child who had sustained at the same time—

1. A separation of the lower epiphysis of the humerus which had been displaced inwards *en bloc*, and had united in this position;
2. A fracture of the capitellum; and
3. A complete outward dislocation of both forearm bones.

By chiselling off part of the humerus the dislocation was (with difficulty) reduced, and a good moveable joint obtained.—J. H.

should be made every three or four days during the first fortnight, and after that every two days. The padded metal splints, which can be altered as regards the angle at every change of dressing, are amongst the most useful; but continuous weight extension may be tried, especially with the elbow flexed, and the traction made in the axis of the forearm. An oblique fracture, on the opposite or inner side involving the trochlear surface, is much less common, and results from force transmitted through the middle of the joint end (a fall on the elbow). The prognosis, on account of the displacement being less, is more favourable than in the last case.

(*e*) *Fracture of the internal epicondyle* is a frequent injury, sometimes resulting from a fall or blow on this projection of bone; much more commonly it occurs from indirect violence, from traction exerted through the internal lateral ligament with the forearm forcibly abducted. The point of bone is at first detached, and then dislocation outwards occurs. The epicondyle is sometimes excessively displaced (even under the trochlea); there is extravasation of blood into the joint with abnormal mobility. In the treatment of this injury Kocher recommends if the epicondyle is moderately displaced that it should be fixed by operation, or in old cases removed by excision. As a result of the examination of the joint in several of these operations Kocher believes that this fracture is almost always due to traction, and that it directly predisposes to outward dislocation.

The fracture of the external epicondyle is excessively rare, but I have known it occur with an inward dislocation of the forearm.

(*f*) *Intra-articular fracture of the capitellum* may occur from a fall on the hand, when the force is transmitted through the radius. The detached fragment, which, as Kocher has shown, may be little more than the layer of cartilage with some adherent bone, remains loose in the joint.

The symptoms are sudden pain and appearance of a distortion at the elbow—hæmarthrosis; later on the arm is kept flexed to an obtuse angle, with the elbow slightly abducted, the internal epicondyle projects more than normal, the head

of the radius appears to be subluxated, movements are free, except full extension and supination, which are limited and painful. The detached capitellum may be clearly distinguished.

Treatment.—Excision of the detached piece of bone through an incision made in the outer side.

Fractures in the form of a T, a Y, and a V are severe injuries, complicated not only by involvement of the joint, but also frequently by wounds of the soft parts. The lower end of the humerus seems particularly disposed to longitudinal fracture, such as is shown in Plate XXXVI, fig. 2 (the result of a gun-shot injury). A correct diagnosis is not impossible, since either lateral portion of the lower end of the humerus can be moved on the other, and on the shaft. In the treatment antiseptic dressings should be applied to the wounds with weight extension, the elbow being straight.

Dislocations of the Elbow.

We have to distinguish between dislocations of both bones, and those of one only (either radius or ulna).

A. *Backward dislocation of both bones.*—No form of displacement is easier to produce on the dead body than this, first by hyper-extension sufficient to tear the capsule in front, and then forcible backward pressure with the forearm somewhat bent. The elbow remains flexed at an obtuse angle, and flexion is difficult owing to the coronoid process being fixed against the end of the humerus. On the living subject the symptoms are very obvious, and include projection of the olecranon and head of radius backwards, and (to a less marked degree, owing to the covering of the soft parts) of the humerus forwards. The epicondyles are further removed from the olecranon than normal; the length of the humerus is unaltered, but its axis is directed in front of the extremity of the elbow. Traction on the forearm does not cause the displacement to disappear. Occasionally this dislocation is complicated by other injuries,—for example, a fracture of the coronoid process, of the internal epicondyle, of the olecranon, or of the trochlear surface; and the prognosis in such cases must naturally be worse.

Fig. 1

Fig. 2

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PLATE XXXVIII.

BACKWARD DISLOCATION OF THE FOREARM.

Fig. 1.—Dissection of a dislocation artificially produced. Of particular interest is the condition of the annular and external lateral ligaments.

Fig. 2.—Backward dislocation as seen in the living subject. The elbow is flexed to an obtuse angle, the olecranon projects abnormally, and the rounded head of the radius is seen just beneath the skin. The axis of the humerus lies in front of the ends of the forearm bones.

Fig. 76.—Recent dislocation of the left forearm backwards in a boy aged fourteen, showing swelling about the elbow, prominence of the olecranon, and shortening of the forearm.

Treatment.—The method of reduction is shown in Figs. 77 to 80. The supinated forearm is first brought into hyper-extension, so as to release the coronoid process from the olecranon fossa; then traction is made on the forearm, whilst the lower end of the humerus is fixed with the surgeon's other hand, the thumb being placed in front, and the fingers exerting pressure on the olecranon.

Flexion of the joint then completes the reduction.

The after treatment includes fixation of the joint for fourteen days with repeated change of dressing and passive motion, and after that allowing free motion to the joint.

Figs. 77—80.—Method of reduction of a backward dislocation of the elbow.

Fig. 77.—Hyper-extension of the elbow as the first act in reduction. This is shown on the skeleton in Fig. 78.

Fig. 78.—(See description of Fig. 77.)

FIG. 79.

FIG. 80.

Fig. 79.—Downward traction on the forearm.
Fig. 80.—Completion of reduction by flexion of the joint.

B. *Lateral dislocations of the elbow.*—These are not infrequent, the outward variety being the most common, and being often combined with a fracture of the internal epicondyle. This fracture may be the result of direct violence, but is much more frequently due to the drag transmitted through the internal lateral ligament. The ulna, in this form of dislocation, rests against the capitellum, the head of the radius being free still further outwards: as a rule the forearm is at the same time displaced somewhat backwards. The internal lateral ligament is either torn or the epicondyle dragged off. If the forearm is dislocated inwards the external lateral ligament will similarly be torn through. In the first case the trochlea projects strongly under the skin, and the internal epicondyle is probably found to have been broken off; in the second case the capitellum and external epicondyle project, unless the latter has been torn off, and on the opposite side of the joint the articular surface of the ulna can be felt.

Treatment.—Under anæsthesia the elbow should be hyperextended and direct lateral pressure made, followed by traction and flexion of the joint. If some obstacle interposes,

Fig. 1

Fig. 2

Fig. 3

PLATE XXXIX.

OUTWARD DISLOCATION OF THE FOREARM, WITH DETACHMENT OF THE INTERNAL EPICONDYLE.

Fig. 1.—Dissection of the right elbow seen from in front, showing lateral displacement of both bones of the forcarm, with tearing off of the epicondyle, which is still connected with the ulna by the internal lateral ligament.

Fig. 2.—The same dislocation viewed from thc outer side. The contour of the front and back of the arm and forearm are but little altered, but the head of the radius projects strongly under the skin.

Fig. 3 shows the same dissectcd.

repeated lateral movements (extension with abduction, &c.) may be sometimes of use. If however reduction fails the joint should be opened (best by two lateral incisions), since by this means sometimes excellent results are secured.

c. *Forward dislocation of the elbow* is a very rare accident, which may occur from a blow or fall on the olecranon when the joint is fully flexed; it is unnecessary to say more on this subject.

Dislocation of one bone forwards and of the other backwards is also very rare. In its treatment each bone must be reduced separately. Isolated dislocation of either radius or ulna is occasionally met with, especially of the radius, the head of which may be displaced forwards, backwards, or outwards.

Backward dislocation of the radius alone is very uncommon; it can be easily recognised by palpation, the elbow is half pronated, and the patient is unable to extend or supinate the forearm. Reduction is made by vigorous traction, direct pressure, and adduction of the forearm.

Forward displacement of the radial head is more common, and may result from a blow on the back of the radius, or from a fall on the pronated hand. The head of the radius projects forwards above the capitellum, and produces an abnormal convexity in the region of the supinator muscles. The forearm is slightly flexed and pronated, active supination is impossible, and flexion can only be done to about a right angle. If uncomplicated with fracture of the ulna in the upper third there will be shortening of the radial side of the forearm. Reduction is best effected with the elbow bent and supinated by strong traction. In all these cases where the radius alone is dislocated the orbicular ligament is either torn, or the capitellum slips out of its grasp. Not uncommonly, particularly in the forward dislocation, reduction is rendered difficult or impossible owing to the interposition of part of the capsule. In these cases arthrotomy should be done, and reduction effected after dividing the interposed soft parts. In making the incision care should be taken to place it sufficiently far outwards to avoid the radial nerve; only in the worst cases is resection instead of arthrotomy indicated.

Under the name of internal derangement of the joint several intra-articular injuries are included; one form we have already noted—a detachment of the capitellum of the humerus. Another variety deserves notice here, and whilst its causation and symptoms are well known, its anatomy continually furnishes subject for controversy. It is met with only in young children, and occurs through a vigorous pull on the infant by the person who is leading it along,—as, for instance, when the child is likely to fall. The symptoms are as follows:—The child hangs the painful arm downward in a pronated position, and cries when supination is attempted. There is no obvious deformity at the elbow. If the forearm be supinated whilst traction is made, and then the elbow flexed, the symptoms disappear, and the child will again use the arm; it is, however, better to keep the part quiet on a sling for a few days. These cases, which exactly resemble each other, are explained by some surgeons as being due to an incomplete form of dislocation of the head of the radius, by others as a nipping of the undamaged capsule of the joint (the posterior part) between the head of the radius and the humerus.[1]

Fractures of Both Bones of the Forearm.

These result chiefly from falls or blows. Amongst children greenstick fracture is not uncommon. The middle third of the bones is usually involved, and if they are broken about the same level the displacement is more marked than if the fracture involves one bone at a different level from the other. Should the bones be much displaced towards each other, union may occur between them, or a sort of articulation result, as shown in Plate XL, fig. 3. In both cases the use of the fore-arm will be much interfered with. The treatment of these fractures deserves special note, and calls for much skill. One

[1] There is really no cause for further controversy on the nature of this accident. It is undoubtedly and invariably due to the cartilaginous head of the radius slipping out of the grasp of the orbicular ligament. When the forearm is flexed and then fully pronated, the radial head again returns to its place. These facts can be perfectly worked out by experiments on the dead subject.—J. H

Fig. 1

Fig. 2

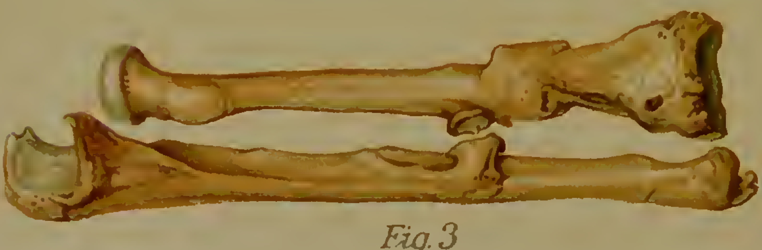

Fig. 3

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PLATE XL.

FRACTURES OF THE FOREARM NEAR ITS CENTRE.

Fig. 1.—Typical deformity due to a fracture occurring in a boy who came under observation when the fracture had begun to unite. Under an anæsthetic the union was broken down, and the limb carefully put up on a dorsal splint with the elbow extended. A good result followed.

Fig. 2.—The bones of the right forearm seen from in front, from a case similar to that shown in fig. 1. The radius is firmly united by bone, the ulna shows a false joint, and both bones present an angular bend.

Fig. 3.—Specimen from a fracture of both bones united in fairly good position, but with great limitation of rotatory movement, due to projections of new bone from both radius and ulna, which fit together. There was marked arthritis deformans in elbow and wrist joints.

must be very careful that the retentive apparatus does not press the two bones towards each other. The first point then is to see that the splints are wide enough to project along the sides of the forearm. The second point is in what position to maintain the forearm; naturally the elbow is to be bent to a right angle, and the wrist extended. Almost complete supination will best ensure the bones being kept parallel. Plate XLI, fig. 2, shows how the upper fragment of the radius will be supinated by the biceps. Should then the lower fragment unite in the pronated position, marked loss of the power of rotation will obviously result.

Fig. 81 illustrates what we may term a supra-condylar fracture just above the wrist, in which the tendency of the bones towards approximation is well marked. We must therefore lay stress upon careful adjustment of the fracture in the supinated position, with the use of sufficiently wide splints applied to the dorsal and anterior surfaces of the forearm. The splints must be really well padded, and the fingers left free. At the end of eight days they should be

Fig. 81.—Fracture of both bones of the left forearm a short distance above the wrist.

removed, and the fractured part examined. If a lateral projection at the site of fracture is threatened, an additional splint may be required. At the second change of dressing

passive motion and massage should be begun. Delayed formation of callus or false joint should be treated in the manner already described.

Fractures of the Ulna (Plates XXXVI and XLII).

A. *Fracture of the olecranon.*—This results as a rule from a fall on the elbow, from direct violence, very rarely from muscular action alone, or from the olecranon being pressed against the humerus in hyper-extension. The symptoms of the fracture are simple, since it is nearly always a transverse one, and since the upper fracture is drawn upwards by the triceps. There is always extravasation of blood in the joint. The patient cannot extend the elbow. As a rule the upper fragment can be drawn down sufficiently to procure crepitus. In those exceptional cases where the periosteum and lateral parts of the triceps are untorn the prognosis is naturally the most favourable, since bony union will almost certainly occur. In the commoner cases where the fragments have been separated fibrous union is the rule. This is partly owing to the fact that there is no periosteum on the joint aspect, but only a thick layer of cartilage, and on either side the fibrous insertion of the triceps; hence callus is formed with difficulty.

Treatment.—The arm must be put up with the elbow fully extended, so that the upper fragment which is drawn up by the triceps is approximated as much as is possible to the lower one, and it may be fixed in this position fairly well by narrow bands of strapping, which loop over the top of the olecranon. It is obvious that the line of fracture must involve the elbow-joint, and sometimes it is advisable to evacuate by puncture the extravasation into the latter which may be keeping up the separation. An early resort to massage is advisable, and of late has been recommended from the first, and it would appear to have given good results. Primary suture of the fragments may be carried out if the aseptic methods of the operator can be relied upon, and if undertaken with the resources of a surgical clinic is quite justifiable, though as a universal method it is certainly not to be recommended.

Fig.3a

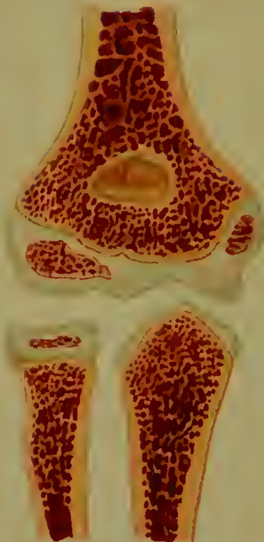

Fig.3

Fig.1

Fig.4

Fig.2

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PLATE XLI.

Fig. 1.—Fracture at the centre of radius and ulna, in which the callus has bound the two bones together. No doubt the splint used was not broad enough, and the two bones have been allowed to converge at the site of fracture.

Fig. 2.—Fracture of the radius alone (experimental), showing how the upper fragment is supinated by the biceps, whilst the lower fragment is in full pronation when the hand is turned over. Union under these circumstances would be attended with complete loss of the power of rotation.

Fig. 3.—Section through the bones forming the elbow-joint in a young subject, showing the epiphysis at the upper end of the radius, and two bony nodules in the lower epiphysis of the humerus, one for the capitellum, the other for the trochlear surface.

Fig. 3 *a*.—Vertical section through the upper end of an ulna, from a child.

Fig. 4.—Lower epiphyses of the radius and ulna.

Fig. 2

Fig. 3

Fig. 4

Fig. 1

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PLATE XLII.

FRACTURES OF THE OLECRANON AND CORONOID PROCESS.

Fig. 1.—Dissection of an artificially produced fracture of the olecranon. The drawing shows how the elbow-joint is opened in such an injury, and how the upper fragment will tend to be drawn upwards by the triceps.

Fig. 2.—Specimen of fractured olecranon which had been united by fibrous tissue as shown in fig. 3.

Fig. 4.—Fracture of the coronoid process at its base, showing displacement due to brachialis anticus.

if only a correct diagnosis be made. Under an anæsthetic direct traction is made on the forearm, so as to get the fracture into good position; further, with the elbow flexed, pressure is made upon the head of the radius, so as to force it into its normal position. There will probably be a tendency to recurrence of the displacement, and to obviate this the elbow should be put up in the flexed position and supinated on a back splint, so that direct pressure may be employed through a pad over the radial head.

In old cases of this kind osteotomy at the point of fracture of the ulna, and an arthrotomy with reposition of the radial head, or its resection, may be necessary.

D. *Fracture of the ulnar shaft.*—In the case of a fall with the elbow bent, or in warding off a blow with the arm, the ulna may sustain the brunt of the injury, and thus its shaft be broken by direct violence. From an indirect cause such a fracture is of extreme rarity.

The diagnosis is easy, for owing to the superficial position of the ulnar shaft abnormal mobility and crepitus are easily obtained.

The treatment is conducted on the same principles as that for fractures of both bones of the forearm; marked displacement can hardly occur if the radius be intact. The styloid process of the ulna is frequently broken off in cases of Colles's fracture of the radius; it is very rarely broken alone. In either case union by fibrous tissue will probably result.

Fractures of the Radius.

A. *Fracture of the head.*—This is wholly intra-articular; it may be complete or incomplete (fissure or bending). In the latter case the diagnosis is naturally difficult and uncertain. Cases of complete fracture are to be recognised when the head of the radius is abnormally moveable with crepitus, but it may be noted that in such cases the movement of the head in pro- and supination seems to be unaffected. Pain is naturally localised to the region of the radial head. This fracture may be due sometimes to direct, more frequently to indirect violence, and the elbow may be either extended or

Fig.1

Fig.3

Fig.2

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PLATE XLIII.

DISLOCATION OF THE HEAD OF THE RADIUS WITH FRACTURE OF THE ULNA IN THE UPPER THIRD.

Fig. 1.—The left elbow seen from the outer side. There is marked displacement at the site of fracture in the olecranon, and the head of the radius rests above the external epicondyle.

Fig. 2.—The same injury taken from a photograph of a young subject. The angular bend of the ulna and the projection of the radial head are all shown.

Fig. 3.—A very similar dissection to that given in fig. 1, the radial head being, however, displaced more directly upwards.

flexed at the time. There are naturally present the signs of injury to the joint, and not infrequently this fracture is overlooked, and considered to be only a contusion or distortion of the elbow. Occasionally the radial nerve is damaged at

FIG. 82.

FIG. 83.

Figs. 82 and 83.—Fracture of the head of the radius which has united by bone. It was obtained by resection from a woman aged twenty-eight, who had fallen on the outstretched hand. The joint was stiffened at an obtuse angle, and pronation was limited.

the same time. Since one can make no direct pressure on the small upper fragment, union will probably take place, in spite of all precautions, with considerable deformity and limitation of movement, which may later justify operation and resection of the radial head. Fractures of the neck of the radius and traumatic separation of the upper epiphysis are both extremely rare, as also are fractures of the radial shaft alone.

B. *Fracture of the lower end of the radius* (Plates XLIV, XLV, XLVI, XLVII).—This form of fracture is very common, and of the greatest practical importance. Its symptoms are remarkably constant. The line of fracture usually runs from $1\frac{1}{2}$ to 2 cm. above the articular surface, *i. e.* where the compact bone of the diaphysis passes into the spongy tissue of the articular end. Not infrequently the lower fragment does not include the whole articular surface, since the line of fracture passes into the latter, breaking off a small portion of it.

The cause of the fracture is almost always a fall on the hand, the thumb side of which receives the impact. The wrist is forcibly extended, and the cancellous tissue of the

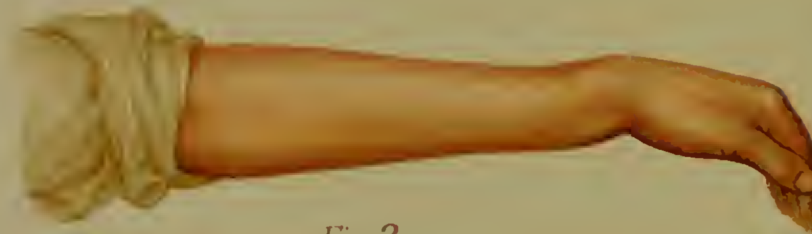

Fig. 2

Fig. 1

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PLATE XLIV.

TYPICAL FRACTURE OF THE LOWER END OF THE RADIUS.

Fig. 1.—Longitudinal section through the middle line of the forearm. The projection forwards of the lower end of the upper fragment into the pronator quadratus muscle and the corresponding hollow at the back of the wrist are evident.

Fig. 2 shows the usual deformity.

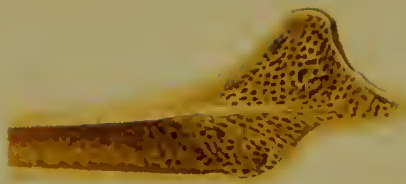

Fig. 1

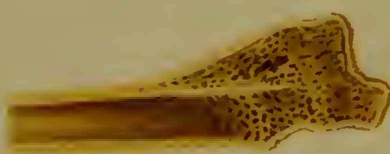

Fig 2

Fig. 5

Fig. 3

Fig 4

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PLATE XLV.

COLLES'S FRACTURE.

Figs. 1 and 2.—Specimens showing impaction of the shaft, but the lower fragment united by bone, and with the articular surface for the carpus tilted backwards.

Fig. 3.—Fracture artificially produced, showing the displacement towards the radial side, and the abnormal projection of the styloid process of the ulna.

Fig. 4 shows the typical deformity on the living subject.

Fig. 5.—Old Colles's fracture with marked arthritis deformans. The radius in this case is the same as that shown in Fig. 3.

back of the hand, when the displacement will be in the direction of the palmar aspect. The symptoms are characteristic enough, but a very careful examination should be made in any doubtful case. The surgeon should seat himself facing the patient, whilst the latter places both hands, with the forearms bare, so that they are exactly in a symmetrical position. If a Colles's fracture is present the following points will be noticed. The styloid process of the ulna projects more strongly than on the sound side (see Plate XLV, figs. 3 and 4); the hand is pushed towards the radial side, so that the line of axis of the forearm passes through the ring or little finger instead of the middle one; the region of the styloid processes appears to be increased in width. When the surgeon examines the part from the side, an abnormal projection is noticed on the palmar aspect of the wrist, and an abnormal depression on the dorsal. In other words, there is a sort of bayonet projection due to the displacement backwards of the lower fragment. This displacement on the radial side is due far more to the line of action of the force which produces the fracture than to any muscular contraction.

It should be noted that the ordinary symptoms of a fracture are not always pronounced; for instance, abnormal mobility may be absent owing to impaction, and in any case is difficult and unnecessary to produce. The same applies to well-marked crepitus. There will probably, however, be tenderness exactly over the line of fracture, and digital examination to determine this is a great assistance in confirming the points already noticed in dealing with the inspection of the injured part.

The prognosis depends chiefly upon the treatment; if the latter be properly carried out perfect recovery in every sense may result.

In my possession is the specimen from a recently united Colles's fracture in an old woman, who died shortly after her recovery from the injury, from pneumonia. It shows bony union without the slightest displacement.

Treatment.—Reposition must be effected by direct pressure and traction on the hand whilst the latter is forcibly bent. This is best done under an anæsthetic. It is

advisable to have two assistants; one of them grasps the patient's hand, the other the upper arm, as shown in Figs. 85 and 86. If reduction is effected in the manner indicated

Fig. 85.—Method of reducing impaction in a case of Colles's fracture.

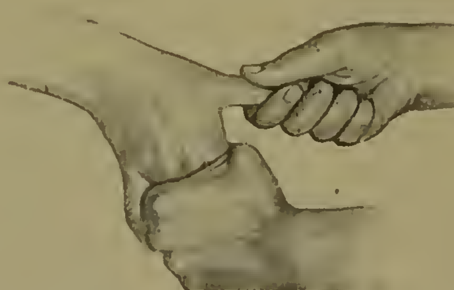

Fig. 86.—A slightly different method of making traction from that shown in the previous figure.

there is, as a rule, no tendency to new displacement. The apparatus or splint must fix only the forearm, the wrist, and carpus. It is unnecessary to fix the elbow, and it is wrong to confine the fingers, since if the latter be fixed for some time troublesome stiffness will result in many people, a stiffness which may never be recovered from, and which in any case requires a painful after-treatment in the way of massage and passive motion. The hand must be flexed, and more bent, if possible, on the radial than the ulnar side, whilst the tendency to abduction is overcome.

These objects can be obtained by the use of a plaster-of-Paris splint (Fig. 87), or a bent metal one (Fig. 88). The

Fig. 87.—Application of plaster-of-Paris splint after reduction of the displacement. The patient's thigh serves as a support for the forearm, whilst the hand is bent over the knee.

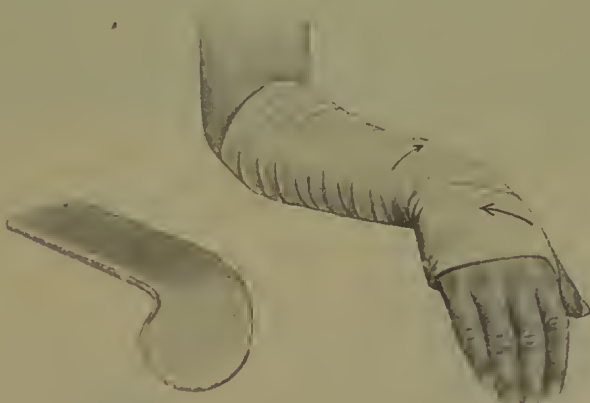

Fig. 88.—Position of the hand on a palmar splint bent in two directions, as recommended by Schede. The splint is shown alongside, and the direction of the turns of bandage indicated by arrows.

following method I have found of special value:—After complete reduction of the deformity, and full adduction of the wrist, a band of strapping about 10 cm. wide is applied around the lower end of the forearm, whilst a second

one surrounding the forearm a little higher up leaves a gap through which suspension can be arranged in the manner shown in Fig. 89. I have used this method myself in only

Fig. 89.—Colles's fracture treated without splints by bands of strapping and suspension.

five cases, but Storp has had an experience of it in no less than 108 cases, in only four of which was it found unsuitable.

In exceptional cases it may be necessary to keep the forearm fully supinated, as shown in Fig. 90, where Roser's

Fig. 90.—Roser's apparatus for treating Colles's fracture in full supination.

splint, which seems to me unnecessarily cumbrous, is applied. It must never be forgotten that Colles's fracture requires frequent change of apparatus, early massage, and active motion.

It is certainly better that such a case should recover with slight displacement, but with perfect mobility of the fingers and wrist, than without displacement, but with greatly impaired mobility. If the fracture has been complicated with detachment of the styloid process (see Fig. 91),

Fig. 91.—Colles's fracture of the radius, with detachment of the styloid process of the ulna united (so far as the radius is concerned), with but little deformity.

or with a fracture higher up through the ulna, the mobility of the lower radio-ulnar joint may be impaired, and occasionally excision of the loose styloid process may become necessary in order to improve the range of movement.

Separation of the lower radial epiphysis is fairly common in young subjects; the symptoms and treatment of this injury are very similar to those of Colles's fracture.[1]

[1] Separation of this epiphysis was one of the earliest to be clearly recognised, Cloquet recording a case sixty-five years ago. The separation occurs, as a rule, exactly at the epiphysial line, though some fragments of the posterior edge of the diaphysis may be driven backwards with the displaced epiphysis. The injury is nearly always due to a fall on to the front of the hand; in all the recorded cases the age of the patient has been between

Dislocation of the lower radio-ulnar joint is very rare, in spite of the weak ligaments and frequent exposure to injury of the part. The lower end of the ulna may be displaced backwards in a fall, or from forced pronation; or forwards, owing again to a fall, or in excessive supination. Amongst washerwomen we sometimes see a sub-luxation of this joint, arising from continual rotatory movements during washing clothes. There is nothing special to say about the symptoms or treatment.

Dislocation of the hand at the radio-carpal joint is extraordinarily rare, and we know that in the past the cases that were diagnosed as such were almost all examples of Colles's fracture. The instances of undoubted dislocation which have been recorded only number about thirty, and some of these were complicated with fracture of the styloid process and radius. They were due to falls on the outstretched hand, which was strongly bent forwards or backwards at the time, and the carpus might be displaced backwards or forwards accordingly. Little difficulty exists in the diagnosis or the reduction.

five and nineteen. When the epiphysis has been merely loosened the diagnosis may be difficult, and it is perhaps just in such cases that neglect of treatment may lead to premature ossification and arrest of growth at this important epiphysial line. The ulna continuing to grow pushes the hand over, producing in the course of a few years a characteristic deformity. When the displacement backwards of the epiphysis is complete the rectangular end of the diaphysis projects through its periosteal sheath, and perhaps even through the skin. The wrist-joint is not open, but the capsule of the lower radio-ulnar joint is often torn, and sometimes the styloid process of the ulna or the lower end of its shaft is broken at the same time. The accident if compound is a grave one, and many deaths have occurred from it due to suppuration and pyæmia, gangrene, tetanus, &c. In the treatment of these compound cases thorough disinfection should be carried out. The wound should be enlarged, so that any obstacle to reduction, such as interposed tendons or periosteum, can be recognised and held aside. If there is much difficulty, or if the bone has been much contused, it is best to saw off the projecting end, since the periosteum will readily fill the gap, and the growth will probably not be interfered with. In simple cases, provided that proper reduction is effected under an anæsthetic, and the forearm kept on straight splints for three weeks, the ultimate result is almost perfect. I have followed up six cases, and in only one was there any arrest of growth.—J. H.

Tab. 47.

Fig. 1 a.

Fig. 2 a.

Fig. 3 a.

Fig. 4 a.

Tab. 46.

Fig. 1

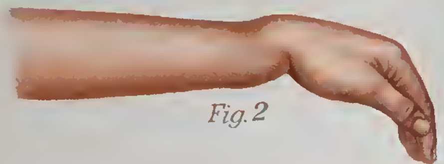

Fig. 2

Fig. 3

Fig 4

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PLATES XLVI AND XLVII.

ILLUSTRATING THE DIAGNOSIS BETWEEN THE DIFFERENT FRACTURES AND DISLOCATIONS ABOUT THE WRIST-JOINT.

Figs. 1 and 1 *a*.—Fracture in the lower fourth of the forearm, with marked backward bending of the bones.

Figs. 2 and 2 *a*.—Colles's fracture (compare Plate XLIV).

Figs. 3 and 3 *a*.—Dorsal dislocation of the carpus, artificially produced.

Figs. 4 and 4 *a*.—Ditto of the metacarpus.

Injuries to the Hand and Fingers.

A. *Fractures.*—Fractures of the carpal bones are rare, and are chiefly observed when the soft parts are much torn or crushed, the gravity of the lesion depending on the latter complication.

Fractures of the metacarpal bones are more common, and result from direct violence such as a fall or blow. Abnormal mobility and crepitus will be noticed, with sharp pain at the point of fracture. There is but little tendency to displacement, since the adjoining metacarpal bones act as a splint, and the treatment is correspondingly simple.

Fractures of the phalanges chiefly result from direct violence, but sometimes from an indirect force acting in the long axis of the finger, and in the case of the terminal phalanges may even result from a violent pull through the tendons attached. The symptoms and treatment (with small padded splints) of these injuries are very simple, on account of the exposed position of the parts.

B. *Dislocations.*—We hardly ever observe dislocation of one carpal row on the other, but single bones of the carpus may be displaced, and form an abnormal projection on the dorsum of the hand.

Occasionally one metacarpal bone is dislocated from the carpus, most frequently that of the thumb, which may be

Fig. 92.—Skiagraph of typical backward dislocation of the first phalanx of the thumb, in a boy aged sixteen.

displaced towards the dorsum, or less commonly towards the palm or the radial side (see Plates XLVI and XLVII, fig. 4).

Dislocations at the metacarpo-phalangeal joints are rare in the case of the second to the fifth digits, but in the thumb are more numerous, and very important in practice. The first phalanx of the thumb is displaced backwards to the dorsal surface of the metacarpal bone. If parts of the joint ends are still in contact we speak of an incomplete dislocation. It is quite possible to produce these dislocations by hyper-extension and forcible backward pressure on the dead subject, and to study in this manner the cause of the difficulty met with in reduction.

Symptoms.—The most marked of these is fixation of the displaced bone, due to the traction of the powerful muscles and stretched ligaments on the part. The lateral ligaments are probably in most cases not torn through, and the insertions of the short flexor muscle, &c., on either side, so to

Fig. 93.—Faulty method of attempting reduction by simple traction. Each pull makes reduction more difficult.

speak, button-hole the metacarpal head, and this prevents reduction by simple traction on the axis of the thumb. It is hardly necessary to lay stress on the abnormal projection of the metacarpal head in front, as well as the altered direction of the first phalanx.

A frequent obstacle to reduction is found in the interposition of the capsule, with the attached sesamoid bones. In other cases the tendon of the flexor longus pollicis may be hooked round the metacarpal head and prevent reduction. This complication may be recognised by slight inclination of the thumb towards the ulnar side, and may be overcome sometimes by still further adducting the phalanx.

Fig. 2

Fig. 1

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PLATE XLVIII.

BACKWARD DISLOCATION OF THE THUMB.

Fig. 1.—Dissection showing the base of the first phalanx displaced on to the neck of the metacarpal bone, on the ulnar side of which lies the tendon of the flexor longus pollicis, whilst on the outer side of it is seen the abductor and part of the short flexor muscles.

Fig. 2.—The same dislocation shown on the living subject.

Exceptionally attempts at reduction may result in twisting the capsule and the outer sesamoid bone round between the two joint surfaces.

It is essential in carrying out reduction first to hyper-extend the thumb, and then by direct pressure against the base of the phalanx to lever it over the metacarpal end. If these efforts fail arthrotomy must be carried out. In all such cases that I have hitherto treated I have succeeded in

Fig. 94.—Correct method, showing the phalanx hyper-extended, and then drawn downwards.

finding through an incision in front of the projecting meta-carpal head the cause of the difficulty in reduction, in effecting the latter, and in securing a moveable joint.[1] In

[1] A method which Prof. Helferich does not allude to will be found more satisfactory than the one mentioned in the text. It is illustrated in Fig. 98. Instead of an open arthrotomy in front of the joint a puncture is made with a tenotomy knife from the dorsal aspect, and the glenoid ligament is divided between the sesamoid bones, the knife cutting downwards until it comes in contact with the base of the first phalanx. Directly the glenoid ligament is completely divided it gapes, and slight pressure will allow the head of the metacarpal bone to return into place. By this method, which was long ago introduced by French surgeons, no structure of

old cases resection of the metacarpal head may be necessary. Dislocations of the first phalanx of the other fingers are

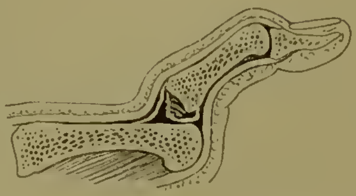

Fig. 95.—The interposed capsule as an obstacle to reduction.

Fig. 96. Fig. 97.

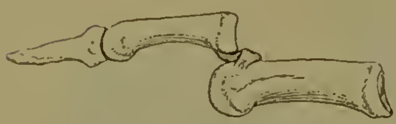

Fig. 96.—The sesamoid bones interposed.

Fig. 97.—The tendon of the flexor longus pollicis fixed at the back of the metacarpal head, and acting as an obstacle to reduction.

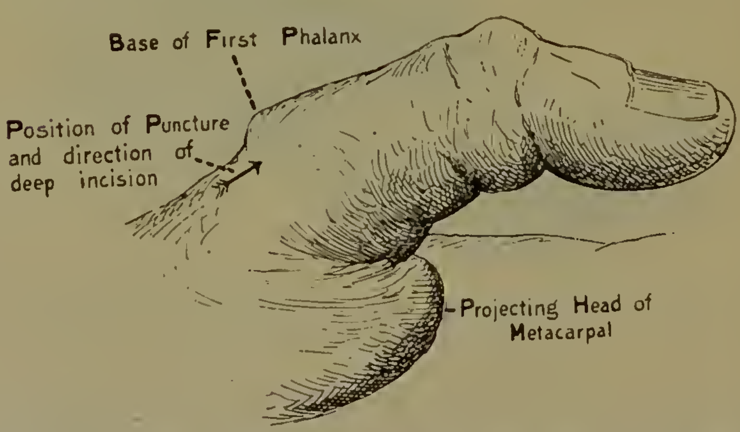

Fig. 98.—Backward dislocation of the first phalanx of the thumb. The small arrow marks the point at which the knife should be entered in order to divide the glenoid ligament, *i. e.* on the dorsum close to the extensor tendons; it also shows the direction in which the cut should be made downwards against the displaced phalanx.—J. H.

usually of the backward variety, as in the thumb. Here also the capsule may be interposed. These dislocations are

any importance is divided except the glenoid ligament, which is the one great obstacle to reduction, and the skin wound is merely a puncture.—J. H.

not infrequently compound; reduction is effected by hyper-extension and direct pressure. Dislocations of the other

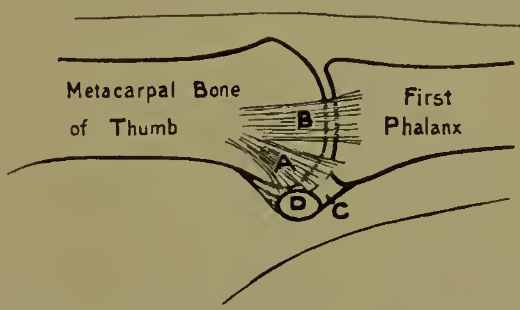

Fig. 99.—Diagram showing the metacarpo-phalangeal joint of the thumb. A and B are the two bands of the lateral ligament, the former being attached largely to the sesamoid bone D. At C is the firm attachment of the glenoid ligament to the phalanx, which always remains intact in the dislocation.—J. H.

Fig. 100.—Dorsal dislocation of the second phalanx of the little finger, from a boy of fifteen.

Fig. 101.—Dorsal dislocation of the second phalanx, middle finger, shown in section.

Fig. 102.

Fig. 103.

Figs. 102 and 103.—Dorsal and palmar dislocation of the terminal phalanx.

phalanges are not very infrequent, and are sometimes reduced by the patient himself. They may occur backwards, forwards, or laterally. Neither the diagnosis nor reduction offers any difficulty.

CHAPTER IV.

FRACTURES AND DISLOCATIONS OF THE LOWER EXTREMITY.

The injuries of the lower limb are so far of greater importance than those of the upper, in that they call for not merely the correct treatment of the particular injury, but also special care in the matter of the general condition of the patient. In the case of fractures of the thigh, &c., in old and weak patients especially, it is of importance not to confine them to bed for long, but to allow them to sit up as soon as possible, with suitable apparatus, for fear of hypostatic pneumonia.

Fractures of the pelvis (see Plate XLIX) occur as a rule only from severe injuries, such as a fall from a great height, being run over, &c. We may have either true fractures of the pelvic girdle or diastasis at either the sacro-iliac joint or the pelvic synchondrosis.

It is obvious that the diagnosis may be difficult unless the bones have been completely separated.

Fractures of the ilium are rarely complicated by injury to the contained viscera, and although they may unite with considerable displacement, will probably give rise to no trouble. Those of the pelvic girdle are more important on account of the injuries to the soft parts which so often complicate them. Of these we may mention damage to the great sciatic and other nerves, to the femoral vessels, to the bladder, to the rectum—all of these being rare; whilst much more frequent, and of the greatest practical importance, are injuries to the male urethra, which latter make themselves known by the escape of blood and hæmaturia. The introduction of a catheter is not only of diagnostic, but also of therapeutic importance. If it is found impossible to introduce it, there is obvious danger of extravasation of urine, with all the

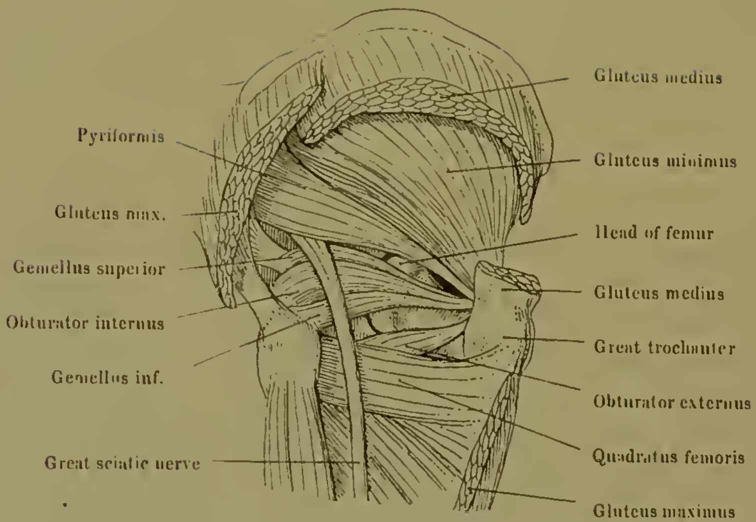

Fig. 104.—Anatomical relations of the hip-joint.

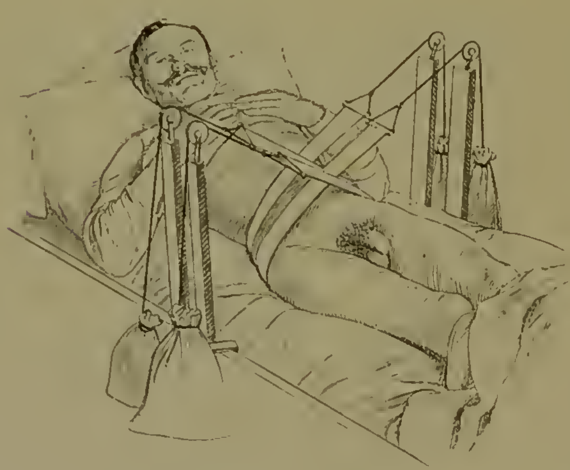

Fig. 105.—Position of a patient under treatment for fracture of the pelvis, with compression applied by means of weights. There was much extravasation around the left hip and left iliac bone, with abnormal mobility and doubtful crepitus, and marked pain on pressure about the left sacro-iliac joint. The injury was due to the fall of a heavy weight on the pelvis. When the patient was discharged with a pelvic band of plaster of Paris, the left iliac crest was 2 cm. higher than the right one.

Fig. 1

Fig. 2

Fig. 3

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PLATE XLIX.

FRACTURES OF THE PELVIS.

Fig. 1.—Severe fracture due to the patient being run over by a wagon. In front the pubis is broken on each side close to the obturator foramen; posteriorly the fracture passes on the right side just external to the sacro-iliac synchondrosis; on the left side this articulation has given way. The specimen represents the double vertical fracture of Malgaigne.

Fig. 2.—Fracture through the acetabulum. The specimen was obtained from a lad, aged fourteen, who had been caught in a threshing machine. There was a severe wound over the adductor muscles, through which the fractured rami of pubis and ischium could be felt. Neither bladder nor urethra were damaged. The patient succumbed from shock, and the specimens figured on Plate I were also obtained at the post-mortem.

Fig. 3.—Fracture of the ilium, not involving the pelvic girdle.

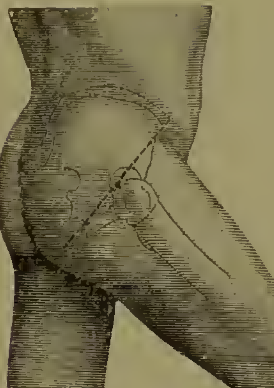

Fig. 106.—Representation of Nélaton's line, the hip being bent.

Fig. 107.—Manipulation method for reduction of a dislocation of the thigh first stage, showing the flexion of knee and hip to a right angle.

risks of gangrene and sepsis. Under these circumstances a free incision in the middle line should be made into the perinæum, which is swollen with extravasated blood. This incision should be made over the region of the bulb, and especially of the membranous portion, and should, if possible, enter the urethra; but a formal urethrotomy is very difficult to execute without the aid of retrograde catheterism, and a supra-pubic cystotomy which would enable this to be done can hardly be carried out by the ordinary practitioner, but it is at any rate the duty of the latter to make a median perineal incision to prevent extravasation and in anticipation of further operative measures.

The forms which fractures of the pelvis take are many.

Apart from force transmitted through the spine and the femora, fractures may arise from antero-posterior pressure, as for instance when a cart passes over the pelvis, or a horse falls on it. We know from clinical and experimental evidence that from such a force fractures in the neighbourhood of the obturator foramen (*i. e.* through the ascending rami of pubes and ischium) together with a separation between sacrum and ilium, or a fracture close to the sacro-iliac joint, will probably occur. An exactly similar result may occur when the pressure is exerted laterally, though on the living subject the violence may be so extreme that we may find fifteen or twenty different lines of fracture. In examining such a case the surgeons should gently press the ilia together, when, if there is a fracture, sharp pain will be felt at its site, with sometimes abnormal mobility and crepitus. A thorough examination of all bony projections, such as the posterior superior spines and the tuberosities of the ischium, should be made on both sides, and sometimes exploration through the rectum is useful.[1] The prognosis depends on the injury to the neighbouring parts, and where this is not present, recovery is to be expected.

In the treatment, rest on a water bed with a suitable pelvic band form the chief points. If the fracture passes through the acetabulum, passive motion of the hip must be carefully undertaken in due time.

Dislocations of the Hip.

These injuries are rare, and always due to severe force. The two chief varieties consist in the forward and backward displacement of the femoral head, and in studying them the researches of Bigelow on the ilio-femoral or Y-ligament are of much importance; for unless this ligament be torn, which

[1] From a fall on the trochanter region the head of the femur may be driven into the acetabulum so that the pelvis is comminuted. Such an injury is difficult to diagnose from an impacted fracture of the neck of the femur; the chief signs by which it might be distinguished would seem to be the marked depression of the trochanter itself (a depression which is also very noticeable in thyroid dislocation of the hip) and by the exaggerated crepitus felt on manipulation. Two cases are recorded by Mr. T. Holmes, 'Path. Trans.,' 1887, p. 231.—J. H.

only occurs in the rarest of cases, the dislocation will always conform to one or other of these regular types.

A. *Backward dislocation at the hip* (retro-cotyloid).—If on the dead subject the femur be bent and rotated inwards, whilst somewhat abducted, the back of the capsule becomes much stretched. If these movements be carried further, the head of the bone may be made to project over the acetabular edge and tear the capsule, the ligamentum teres giving way at the same time. In this experiment the attachment of the Y-ligament forms a fulcrum, and the great length of the long arm of the lever, compared with the short arm, accounts for the force which is exerted to produce the dislocation.

We have to distinguish between a dislocation on to the ilium and on to the ischium; in the first the head of the femur rests above the tendon of the obturator internus, in the ischiatic dislocation below it. In both cases the displacement happens when the limb is rotated inwards as well as flexed, the flexion being greater in the ischiatic than in the iliac form.[1] The force is more often applied to the back

[1] It has been strongly contended that in dislocation both of the shoulder and the hip the rent in the capsule is situated chiefly or entirely at the lower part. Thus Mr. H. Morris states that dislocation of the hip nearly always occurs with the affected limb in the position of flexion and abduction; the head of the femur leaving the joint at its lower part travels backwards, *i.e.* on to the dorsum or ischium, if the thigh is rotated inwards, or rather if the acting force tends to turn the thigh in this direction as well as to force it out of its socket. Morris ('Med.-Chir. Trans.,' 1892) having examined a considerable number of specimens, states that this rule is almost without exception. If the dislocation is a direct dorsal one, that is, if the rent in the capsule is at the upper or back part alone, it is combined with fracture of the cotyloid edge. On the other hand, some writers, including the late Sir G. Humphry and Mr. Eve, have disputed this view, contending that frequently at the moment a dislocation of the femur occurs the thigh is flexed and *adducted*. It is of interest to note that occasionally one femur is dislocated forwards, the other backwards, and I have examined one such case (dorsal with thyroid dislocations). With regard to the humerus there can be no doubt that the dislocation often happens from a fall or blow on the shoulder itself, when the arm is not specially adducted, and the rent in the capsule will be opposite the part struck, *i.e.* usually the anterior portion of the capsule. When comparing the hip and shoulder it must be remembered that the anterior portion of the capsule in the former joint is of great strength, whilst the lower part is the weakest, whilst in the shoulder there is no such difference. The matter is by no means of merely

whilst the femur is fixed, than *vice versâ*. When the head of the bone passes beneath the obturator internus, and the gemelli, these muscles may form an important obstacle to replacement.

Symptoms.—The thigh is rotated inwards and more or less strongly flexed and adducted. There may be some shortening made out on measuring from the anterior superior spine of the ilium to the lower border of the patella. This shortening is greatest in the iliac form, and is especially evident when the two limbs are flexed, still more whilst the patient lies on his back, and the pelvis is kept exactly horizontal. It is most easy to ascertain this when the patient is under an anæsthetic.

The top of the great trochanter is situated above Nelaton's line. The inward rotation, which is present in all the ordinary cases of dislocation backwards, is absent in a few exceptional ones, where the capsule and upper part of Bigelow's ligament are very extensively torn. The upward displacement of the trochanter can also be made out by measuring the distance between it and the anterior superior spine on both sides with the fingers. It is difficult to make out by palpation the displaced head of the femur, especially when there is swelling present. Power of active motion of the hip is lost. Passive flexion and increase of the adduction and inward rotation may be effected, but are painful; and when it is attempted to abduct and rotate outwards the limb there is a characteristic elastic resistance felt, due to stretching of the Y-ligament.

The more extensive the range of passive motion and the less the inward rotation of the limb, the more certain may we be that the capsule and muscles are much torn.

Treatment.—It has been already noted that for the examination of a case of dislocation of the hip, the patient should be thoroughly anæsthetised, and the same applies to the reduction.

theoretical importance, for the success of Kocher's method of reduction of dislocation of the shoulder is said to be largely due to the fact that the rent is chiefly placed in the lower quadrant, and that by raising the elbow to the level of the shoulder the head is brought opposite to this rent.—J. H.

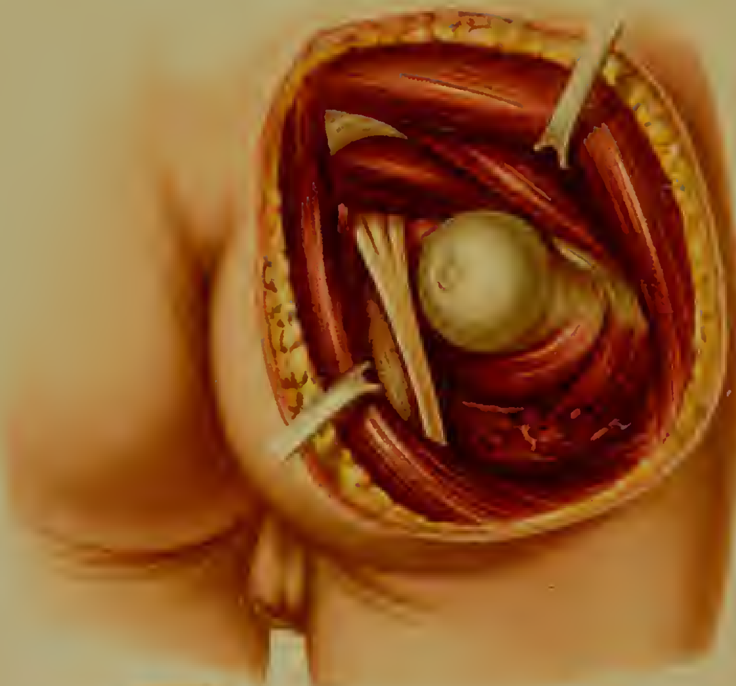

Fig. 1

Fig. 2

Fig. 3

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PLATE L.

Fig. 1.—Dislocation of the femur on to the ischium produced artificially. The gluteus maximus has been divided in its long axis and held aside, and the deeper muscles also separated so that the head of the bone can be seen. The gluteus minimus and pyriformis are clearly seen above the head; the obturator externus and the quadratus femoris, part of whose fibres were torn, are displayed. The great sciatic nerve is clearly seen just to the inner side of the head, and close to it the origin of the hamstring muscles from the tuber ischii.

Fig. 2.—Dissection of the normal hip for purposes of comparison (for explanation see Fig. 104).

Fig. 3.—Dislocation on to the ilium, showing the head placed above the obturator internus.

The patient lies flat upon the ground or a hard mattress, his pelvis is steadied by an assistant, or in case of necessity where no assistance can be had, by the operator's foot (naturally with the boot removed). The affected limb is then bent at a right angle to the trunk, the knee being also flexed to a right angle; sometimes, if the head is situated just behind the acetabulum, simple direct traction upwards suffices to reduce it, but in most cases the thigh must be abducted and rotated outwards.[1]

The interposed capsule may form an obstacle to reduction, which may be overcome by various movements of the hip; occasionally it may be necessary to divide it by incision. I have thus succeeded in getting back a dislocation of some weeks old in a child with recovery of good mobility. In old unreduced cases, resection of the head or even osteotomy below the trochanters may be indicated.

B. *Forward dislocation* (præcotyloid).—This form of displacement is rarer than the backward one; in it the capsule tears at its front part, the head of the bone rests on the pubis over the obturator foramen or even towards the perinæum, the limb is rotated outwards and abducted, the degree of flexion varies, being but slight in the pubic form, whilst the lower the head is displaced the more will the thigh be flexed. If placed over the pubis the head is easily felt through the skin, the femoral artery may be lifted up, and there may be pain from the stretching of the anterior crural nerve. If the head is displaced more downwards, flexion and abduction with outward rotation are certain to be present. In the differential diagnosis we may distinguish

[1] The author recommends traction with the thigh adducted and rotated inwards as the routine, and if this fails abduction and outward rotation, but does not give any reason for departing from the practice generally found successful, and I have therefore ventured to alter the text slightly. In attempting reduction by manipulation of a dorsal or ischiatic dislocation there is a considerable risk of flexing the thigh too much and making the femoral head travel below the acetabulum into the thyroid foramen, or in the case of thyroid dislocation converting it into a dorsal one. Once this has occurred the surgeon may find himself much embarrassed by its repetition on every fresh attempt. Direct traction in the axis of the thigh whilst the head is brought down will probably succeed in levering it over the acetabular edge.—J. H.

a fracture of the neck by the facts that the thigh is shortened and rotated outwards, that the elastic mobility is absent, but that the limb can be got into position by simple traction, whilst it returns into its former position directly the traction is removed; finally other movements can be effected than those allowed in dislocation.

Reduction.—In the pubic form direct traction when the limb is extended may suffice, but usually the limb must be flexed more or less, and inward rotation followed by adduction carried out. Circumduction inwards with simultaneous traction on the limb may be required.

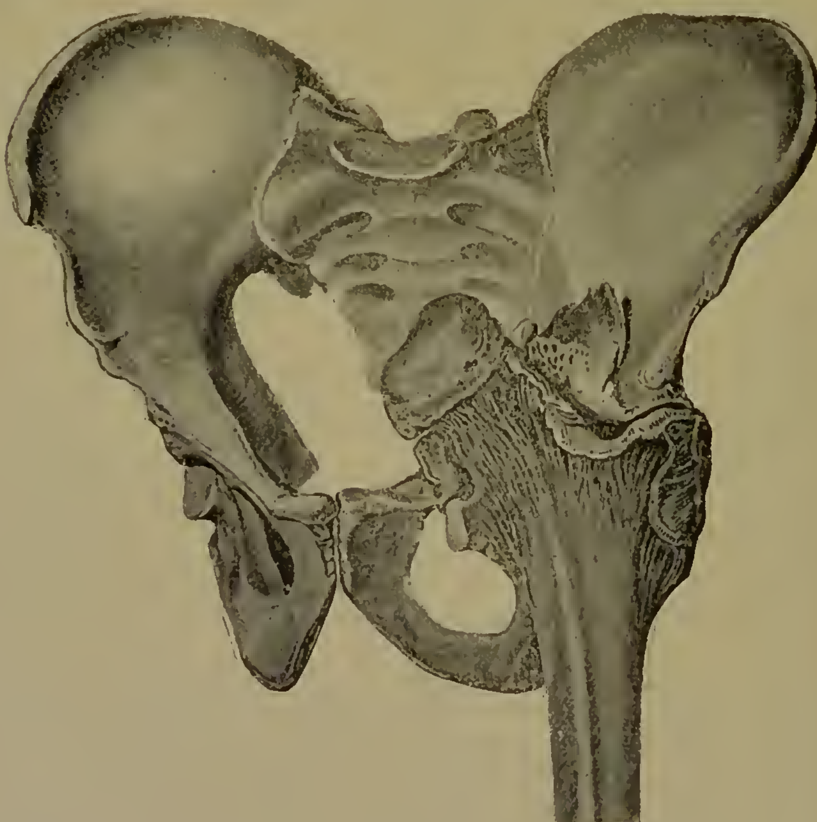

Fig. 108.—From a remarkable case of old unreduced dislocation on to the pubes. The limb was of course considerably shortened, but the man could get about fairly well. The head and neck of the femur have become considerably altered in shape; the great trochanter articulated with the anterior superior spine, the lesser trochanter with the ascending ramus of the pubes. Copied from Sir Astley Cooper.—J. H.

Fig. 1 a.

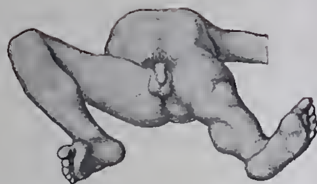

Fig. 3 a.

Fig. 2 a.

Fig. 4 a.

Fig. 1

Fig. 3

Fig. 2

Fig. 4

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PLATES LI AND LII.

THE DIFFERENT TYPES OF DISLOCATION OF THE HIP.

In Plate LII the corresponding positions of the lower limbs are shown.

Figs. 1 and 1 *a*.—Dislocation on to the ischium.

Figs. 2 and 2 *a*.—On to the ilium.

Figs. 3 and 3 *a*.—Into the obturator foramen.

Figs. 4 and 4 *a*.—On to the pubes.

c. *Rare forms of dislocation.*—Downward displacement (infra-cotyloid) is very rare; in it the limb is strongly flexed and slightly abducted. The patient may be able to stand on the affected limb as in the case of pubic dislocation. Reduction is accomplished by traction on the bent thigh. Upward dislocation is also extremely rare; the head of the bone may be felt close to the anterior inferior spine, the limb is extended, rotated outwards, adducted, and much shortened. Reduction by means of flexion and inward rotation.

We have also to note the occasional complication of fracture of the femur (neck or trochanter), or of the edge of the acetabulum, with a dislocation. As an extreme rarity the head of the bone may be driven into the pelvis when the acetabulum is broken. This condition is of interest from its analogy with fracture of the base of the skull through impaction of the condyle of the jaw.[1]

Fractures of the Upper End of the Femur.

We have to distinguish the following forms:

1. Intra-capsular fracture of the neck.
2. Traumatic detachment of the epiphysis of the head.
3. Extra-capsular fracture of the neck.
4. Fracture through the trochanter region.

[1] Unreduced dislocation of the thigh means, as a rule, permanent and grave limitation of mobility in the limb. But this is not always so, for occasionally recovery is almost perfect. Thus in the case of an athletic soldier, recorded by H. Morris ('Med.-Chir. Trans.,' 1892, p. 106), who had a dorsal dislocation with one and a half inches shortening, the knee could be made to touch the shoulder, abduction and rotation were extremely good, but naturally there was a peculiar gait like that of a case of congenital dislocation.

When the dislocation is of very old standing, and much loss of function is present, an operation may be justifiable. This will take the form of—

1. An attempt to replace the bone in the socket after dividing and holding aside the capsule. This is likely to fail.

2. Excision of the femoral head. Two successful cases are quoted by Morris (loc. cit., p. 105).

3. Osteotomy of the femur, either above or below the trochanters. In a case of old thyroid dislocation (pathological) in a young man with great deformity owing to flexion and abduction, I obtained a very good result by infra-trochanteric osteotomy. The limbs were ultimately the same length, and the patient could walk long distances without difficulty.—J. H.

5. Isolated fracture of the great trochanter.

6. Fracture of the femur just below the trochanters.

Fractures of the neck are relatively common; when intra-capsular the vascular supply of the detached head is much impaired, especially as in old people the arterial branches accompanying the ligamentum teres are very small, and the upper fragment may form a sort of loose body in the joint. When partly extra-capsular the vascular supply for the repair of the fracture is much less damaged. In both forms indirect violence may be to blame, such as a fall on the

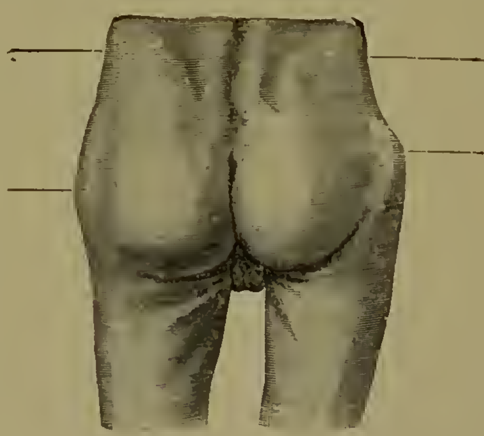

Fig. 109.—From a case of fracture of the neck of the left femur, showing the upward displacement of the trochanter major. This is made especially evident by comparing the relative position of the lines drawn through the anterior superior spines.

knee or the patient tripping up from catching his foot. In other cases a fall sideways on to the trochanter major may produce impaction of the neck into the spongy bone of the trochanter region. The frequency of these fractures in old people is due to the rarefaction of the cancellous bone and the substitution for it of fat, a kind of osteoporosis which is most common in women; further, the angle formed between the neck and the shaft diminishes in some subjects as age advances, a circumstance also favouring fracture.

Pathology.—Plates LIII, LIV, and LV illustrate the chief points, Plate LIII showing the typical intra-capsular fracture resulting in a false joint; the detached head being, as a rule, fixed to the acetabulum by fibrous or even bony adhesions.

Plate LIV shows the more common impacted extra-capsular fracture, after which the amount of callus formed may be excessive. It may be noted that the original impaction may disappear owing to the patient bearing his weight on the limb too soon, and a slight degree of shortening may thus be converted into a very considerable one.

In nearly all cases of fracture of the femoral neck, rotation

Fig. 110.—Vertical section of the femur to show the vascular supply of the head of the bone. It will be seen that a bundle of small vessels run along the ligamentum teres but do not get into the bone, which is supplied by arteries running along the reflections of the capsule (the so-called retinaeula). Copied from Sir Astley Cooper.

of the limb outwards is a marked symptom. This is due chiefly to the fact that the posterior part of the neck is weaker than the anterior, and therefore tends to be more crushed or impacted (as illustrated in Plate LV, fig. 4).

Symptoms.—One should always think of the possibility of a fracture of the femoral neck when an old person, after a fall on the knee or side of the body, cannot stand up, and

when the injured limb is shortened and rotated outwards. In the diagnosis contusions and dislocations of the hip and fractures of the pelvis have to be considered. It is hardly possible to mistake the injury for a dislocation (with outward rotation only a forward dislocation could be possible). In the case of fracture the patient cannot raise the limb from the bed; it lies helpless and shortened to a variable degree, whilst corresponding elevation of the great trochanter above Nélaton's line can easily be made out. Direct palpation of the seat of fracture is difficult, and not of much importance unless the great trochanter region is involved. The trochanter is displaced nearer the middle line than on the normal side, but the determination of this measurement is so difficult and uncertain that the point is of little importance in diagnosis. Passive motion of the injured limb, although painful, can be effected, and crepitus will be felt unless firm impaction is present or the fragments much displaced. Rotation of the limb on its long axis takes place on a shorter radius than on the healthy side; this will be most marked if no impaction exists. In the impacted variety the shortening and outward rotation are usually somewhat less, and of course crepitus should not be obtained. The history is very characteristic when an impacted fracture has occurred and the patient has been allowed to get about without proper treatment.

I may illustrate this point by quoting the case of a woman, aged seventy-four, who fell from a chair in her room on to the hip, but was able afterwards to stand and walk with some pain. This happened on the 17th May, 1896, and at the beginning of August of that year sharp pain with sudden loss of power came on in the hip just as the patient had sat down on the edge of the bed. She now became bedridden and had to have weight extension applied. It will be noticed that in this case the patient had actually walked about two and a half months before the impaction became loosened.

Treatment.—As the patients are chiefly old and enfeebled, attention to improving the general health and careful feeding are especially indicated. The gradual onset of hypostatic pneumonia is to be feared during the necessary confinement

Fig.1a

Fig.1b

Fig.2b

Fig.2a

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PLATE LIII.

INTRA-CAPSULAR FRACTURE OF THE NECK OF THE FEMUR.

Figs. 1 *a* and 1 *b*.—False joint with complete absorption of the neck. The two opposed bony surfaces were smooth and polished, as though from arthritis deformans, and many osteophytes have developed around them. The chief movement allowed was one in the upward and downward directions, and this is indicated in the specimen.

Figs. 2 *a* and 2 *b*.—Impaction of an intra-capsular fracture. Specimen obtained from a woman aged eighty-two. It will be noticed in fig. 2 *a* that the normal contour has been fairly preserved, though the neck is shortened, and the great trochanter higher than normal. In fig. 1 *b* the bone is shown in section. The shaft is slightly adducted with regard to the head.

to bed; frequent changes of posture, &c., should be tried, and the patient got up as soon as possible. The impacted fractures in the trochanter region unite with exuberant callus, whilst the non-impacted fractures of the neck very rarely unite by bone at all.[1] It need hardly be said that great caution should be employed before allowing the patient to bear weight on the limb if the fracture is thought to be impacted. In ordinary cases extension and inward rotation should be secured with weight extension by means of strapping. A weight of 12 to 15 lbs. is usually required; if possible, an apparatus which allows a certain amount of change of position should be employed.

A splint (made of leather, poroplastic felt, &c.), with which the patient may be allowed to get about on crutches, should be made use of early. Operative interference, such as fixing the fragments by steel nails, can only be justifiable in rare cases. Kocher has lately recommended early excision of the detached head in intra-capsular cases as the best method. Should this be contra-indicated by the patient's age, weakness, &c., massage and gentle passive motion should be begun as soon as possible.

The final result is as a rule not brilliant; since the surgeon has to deal with an old and feeble subject he may be content if his patient manages to walk ultimately with the help of a stick.

Traumatic separation of the epiphysis of the head of the femur (see Plate LV, fig. 5).—This is an extraordinarily rare injury, contrasting in this respect markedly with the detachment of the head of the humerus. The explanation is to be found in the small size and sheltered position of the epiphysis of the femoral head, which is wholly within the joint and has no ligament or part of the capsule attached to

[1] Firm bony union of fractures of the femoral neck is not so rare as some authors would lead one to believe, and may occur even in advanced periods of life. In the Royal College of Surgeons Museum (No. 1006) there is a specimen showing firm union of an "intra-capsular" fracture of the neck and a fracture four inches below the trochanter in the right femur of a man, who sustained the first fracture at the age of seventy-three and the second a few months later when attempting to get out of bed. He lived to be seventy-five.—J. H.

it.[1] The diagnosis and treatment offer nothing special to note.

Fracture of the trochanter major is usually only part of an extra-capsular fracture of the neck, but very occasionally this prominence of bone is broken off by direct violence as an isolated fracture. The detached fragment is drawn up by the glutei, and can probably be distinguished. The

[1] The writer must here have forgotten the ligamentum teres and some bands of reflected capsule—the retinacula, which are both connected with the epiphysis.

Up to the age of twelve or eighteen months it is possible that the mainly cartilaginous upper end of the femur, including the head and great trochanter, might be separated from the rest of the bone; but it has never been proved by dissection to have occurred from traumatism during life, and experimental attempts on the cadaver have generally failed. In children and young adults, however, the clinical evidence (which has been lately dwelt on by Mr. Hutchinson in the 'Archives of Surgery') points very strongly to the possibility of detachment occurring exactly at the epiphysial line between the head and neck of the bone. The specimen from an undoubted case of this has been described and figured by M. Bousseau of Paris. The patient, aged fifteen, had been run over by a cart, and after his death from shock it was found that the capsule of the left hip-joint was torn, and that the epiphysis for the head was detached exactly at the epiphysial line. To this solitary case we may add several others derived from the lower animals. In the museum of the Royal Veterinary College there are two examples obtained from horses, in the London Hospital Museum one from a rabbit; these were cases of traumatic detachment of the epiphysis.

That intra-capsular fracture of the femoral neck occurs in young subjects has been proved by specimens described by Coulon, Stanley, and others, and by two in the museums of the Middlesex and Guy's Hospitals.

I have collected records of upwards of twenty cases in which the symptoms (shortening from half to one and a half inches, eversion of the limb, more or less crepitus, alteration of Bryant's measurement, &c.) indicated either a fracture of the neck or separation of the epiphysis in patients under twenty years of age. Dr. Whitman has lately recorded six other examples, and he holds the view that in the majority the lesion is a fracture.

It is only necessary here to allude to the numerous cases in which, after a wrench of the hip, acute epiphysitis has occurred, and the head become thus detached from the neck. Such separation of the epiphysis is, of course, secondary to the inflammatory process. In cases of detachment or of fracture of the neck in young subjects which are primarily due to the accident, bony union appears to follow treatment in nearly all of them. In one, however (recorded by Mayo Robson), a false joint seems to have been formed.—J. H.

Fig. 1b

Fig 1a

Fig. 2a

Fig. 2b

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PLATE LIV.

EXTRA-CAPSULAR FRACTURE OF THE FEMORAL NECK.

Figs. 1 *a* and 1 *b* show the impaction of the neck into the trochanter region, the former being placed almost at a right angle to the shaft. In fig. 1 *b* the normal outline of the femur is indicated, so that the degree of shortening can be estimated.

Figs. 2 *a* and 2 *b*.—Old extra-capsular impacted fracture, the accident having occurred five years before death. The patient, a woman aged eighty-two, was the same from whom the specimen of intra-capsular fracture shown in Plate LIII, figs. 2 *a* and 2 *b*, was obtained.

Fig.1

Fig.2

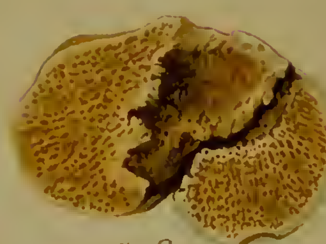

Fig.3

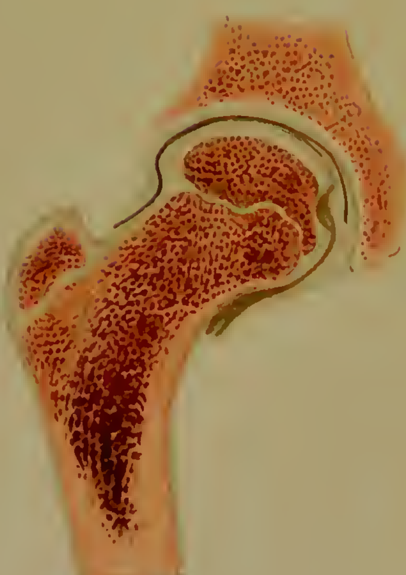

Fig 5

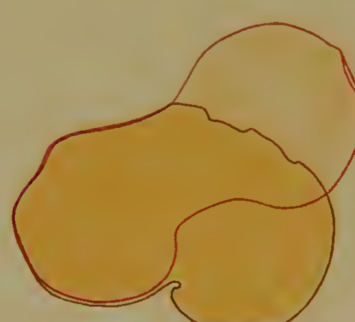

Fig.4

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PLATE LV.

Figs. 1 and 2.—Anterior and posterior views of a specimen of impacted fracture of the neck.

Fig. 3.—Section in the axis of the neck of the same preparation.

Fig. 4.—Diagram illustrating the great impaction that has occurred at the back.

The above figures illustrate the outward rotation of the femur which occurs in these cases.

Fig. 5.—Section to show the epiphyses of the femoral head and great trochanter.

obvious treatment is to fix it in position by means of a steel needle, approximation being favoured by abduction of the thigh.

Fracture immediately below the trochanters.—This variety may be due to direct or indirect violence, and may take the form of a transverse or more commonly a very oblique or vertical fracture; it occurs in adults whose work exposes them to the risk of severe accidents. There is no predisposition to this accident in old age.

Fig. 111.—The specimen which is figured in Plate LVI, fig. 1, is here seen from the outer side; the upper fragment is somewhat flexed; the shaft is displaced upwards and forwards.

Symptoms.—Apart from those common to all fractures, we have to note that the upper fragment tends to be strongly flexed and abducted, owing to the contraction of the ileo-psoas and glutei. When the limb is rotated it will be found that the trochanter does not move with the rest of the femur.

Fractures of the Shaft of the Femur.

These are very frequent, especially just above the centre of the bone; whilst sometimes due to twisting of the limb (or other indirect force), they are more often the result of direct violence. They are common amongst children, and the result in them is usually excellent, since the periosteum prevents displacement occurring. In adults this, however, is usually marked, since

the line of fracture is often oblique and the contraction of the muscles is difficult to overcome. Abnormal mobility and crepitus are almost constant, and if the latter is not noticeable it may be inferred that the soft parts are interposed, so that it becomes necessary to elicit it in order to guarantee good union. Shortening is also readily made out by the usual measurements.

Fractures above the centre of the bone often result in angular deformity, the upper fragment being flexed and abducted by the ilio-psoas and glutei, whilst the lower fragment is drawn upwards by the adductors, &c. Sometimes a false joint is formed (see Fig. 113), and occasionally union takes place with bending backwards of the femur (see Fig. 112).

FIG. 112.

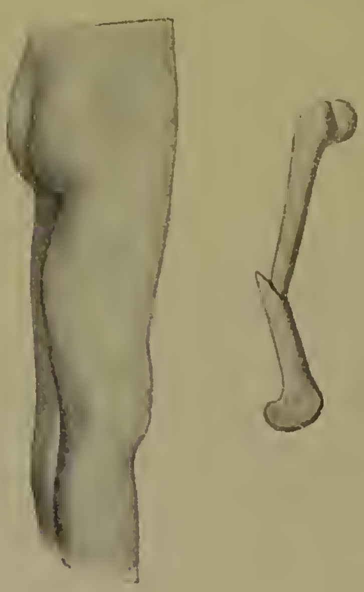

FIG. 113.

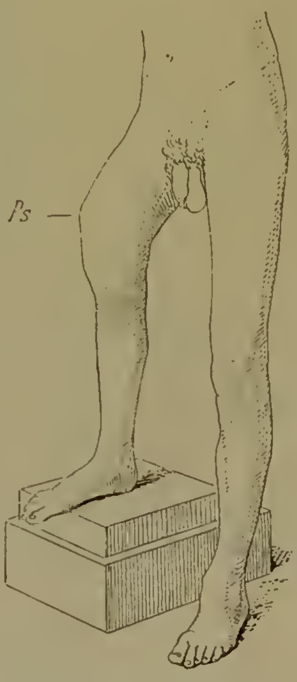

Fig. 112.—Fracture in the middle of the thigh, united with backward bending. Annexed is a sketch of the bone to show the displacement.

Fig. 113.—Fracture just below the centre of the right femur with a false joint and excessive overlapping. Operation: resection of the ends of the bone, with as much extension of the limb as could be obtained. Result: firm union.

Treatment.—This has become quite simple since the introduction of strapping and weight extension; at the same time it must not be thought to require but little care in its application; for example, the bands of strapping must be applied with skill so as to exercise no injurious pressure, and they must be strong enough to sustain a weight of 20 to 25 lbs. Volkmann's apparatus, which allows the foot-piece to slide according to the weight (see Figs. 115 and 116) is useful; counter-extension is best obtained by raising the foot of the bed, whilst the sound limb gets a purchase against a block (see Fig. 115).

Fig. 114.—A simple form of sliding foot-piece for weight extension, which can readily be improvised.

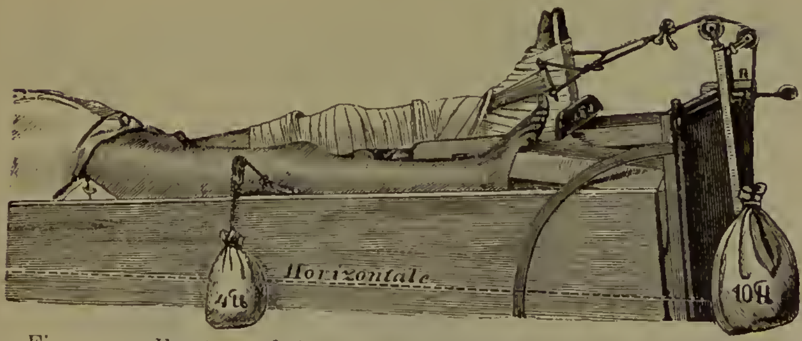

Fig. 115.—Fracture of the femur treated with weight extension, &c.

With the patient so placed the site of fracture is of course accessible to palpation, but owing to the thickness of the muscles the exact position of the fragments cannot always be made out by the fingers, and hence careful measurement of the length of the limb should be made from time to time. If there is any doubt as to the symmetrical position of the

two limbs, that is if the injured limb is really abducted, this fact can be made out after the manner shown in Fig. 116.

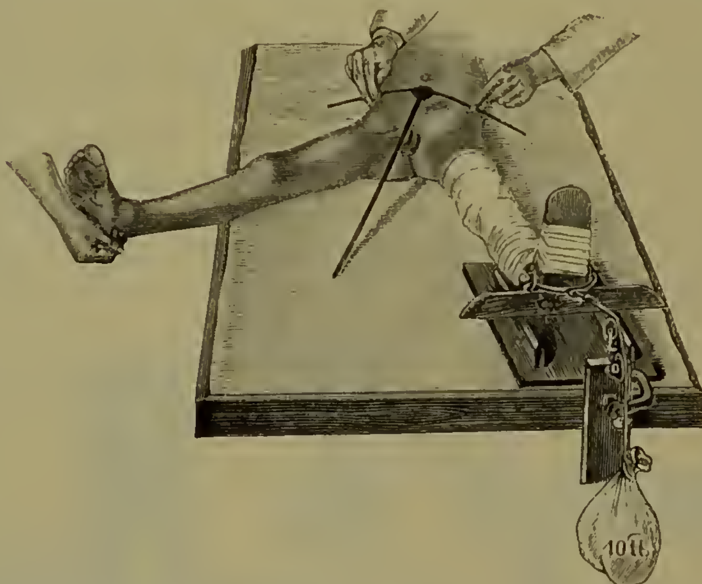

Fig. 116.—Position in which measurements as to the length of the limb after putting up a fracture of the femur should be made. The sound limb is brought into symmetrical position with regard to the pelvis.

Sometimes it is found that simple extension does not suffice to correct the displacement. The rule should then be fol-

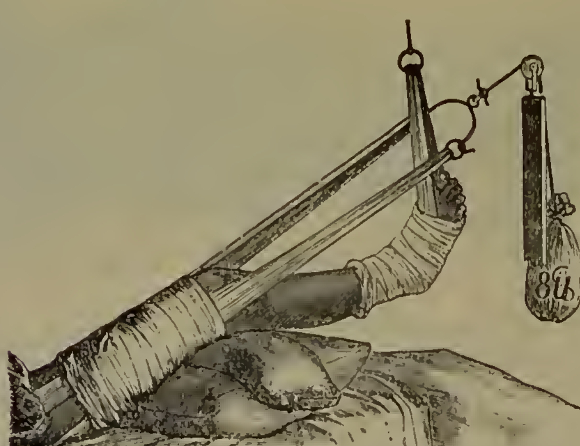

Fig. 117.—Weight extension applied to the thigh in a case where contraction of the knee prevented its application to the leg.

lowed that the lower fragment should be brought into the same position as the upper one; thus, for instance, it may be necessary to flex and abduct the femur, and apply the weight extension in this position, whilst lateral traction by weight may be required to limit the abduction of the upper fragment (see Fig. 118).

Fig. 118.—Weight extension for fracture of the left femur, with counter-extension and lateral traction.

In children we can strongly recommend the use of vertical extension (Figs. 119 and 120). The fear lest this elevation of the limb should cause anæmia and imperfect formation of callus, cannot have much foundation, and if necessary such tendency to anæmia of the limb may be corrected by an india-rubber bandage applied above the fracture as shown in Fig. 6.[1]

In case of fracture amongst newly-born or quite small children the most simple and best method of treatment con-

[1] This passage has been strictly translated, but it is doubtful if the vertical position of the thigh has any advantages, whilst it is certain that a condition of venous stasis, such as would be produced by the india-rubber bandage, could not possibly be of benefit. In practice it is found that the ordinary box splint, both from the surgeon's and the nurse's point of view, is preferable to the "gallows splint," and certainly the methods shown in Figs. 119 and 120 cannot be efficient in securing fixation and rest at the site of fracture unless German children are much more docile than English ones.—J. H.

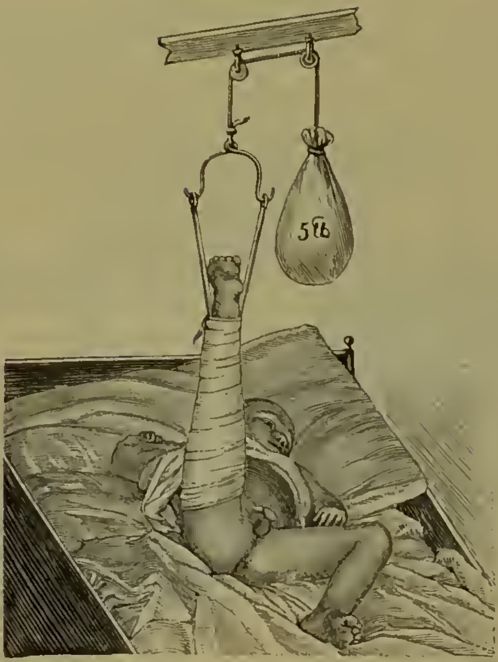

Fig. 119.—Vertical weight extension applied to a child with fractured femur. It will be noticed that the pelvis is tilted by the extension.

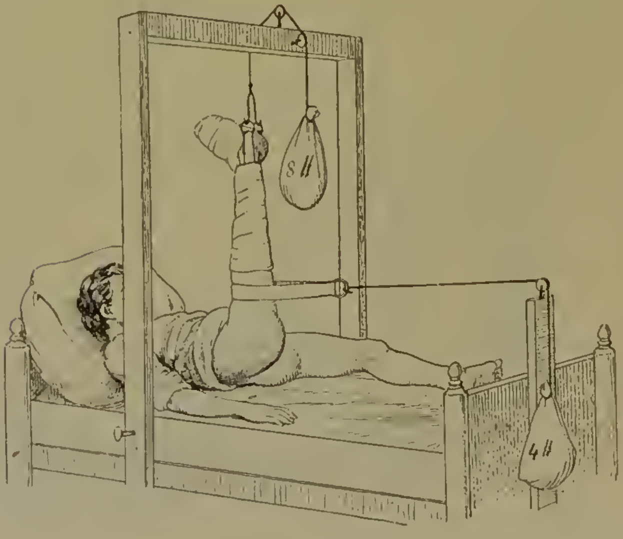

Fig. 120.—Vertical weight extension with lateral traction to correct flexion of the upper fragment.

Fig.1

Fig.2

Fig.3

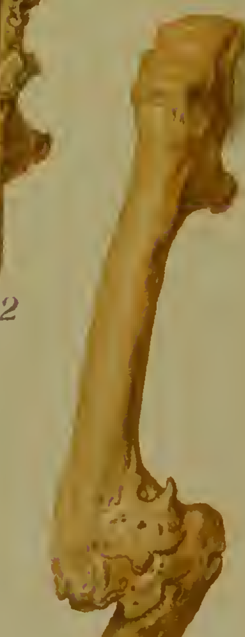

Fig.4

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PLATE LVI.

VARIOUS FRACTURES OF THE FEMUR.

Fig. 1.—Posterior view of an oblique fracture below the trochanters, united with excessive formation of callus.

Fig. 2.—Oblique fracture of the upper half of the femur, due no doubt to violent torsion of the bone.

Fig. 3.—Oblique fracture in the lower half of the femur, with lateral displacement and overlapping, united with much callus.

Fig. 4.—Transverse fracture in the lower half of the femur, united with much overlapping. The displacement of the lower fragment is that which is prone to occur in fractures just above the condyles.

sists in fixing the thighs, strongly flexed upon the abdomen, by means of a broad band of strapping passed round the back and thigh

Plaster-of-Paris bandages find their use in the treatment of fracture of the femur when it is necessary to get the patient up very soon, in the case of the supervention of delirium tremens, or in treating young children. The principle of the ambulatory treatment of fractures of the femur depends upon the apparatus taking its bearing point from the tuberosity of the ischium, so that the lower limb hangs freely in it, and extension may be made whilst the support is applied; for this purpose I have found nothing better than the splint devised by the Liverpool surgeon H. O. Thomas (see Fig. 121). The simplest form of this splint can be made by any blacksmith and saddler. With the use of Thomas's splint it is practicable to get most of the cases about within three to four weeks without any detriment to the union, or to the general condition of the patient. To attempt to apply this treatment, however, from the day of the accident is dangerous, and it can rarely be necessary or advisable to get the patient up before three or four weeks have elapsed. If the fracture is situated in the upper third of the bone, owing to the marked tendency to displacement the ambulatory treatment cannot be recommended. If a fracture of the femur has united with marked deformity, osteoclasis or osteotomy should be performed, and with the subsequent use of strong weight extension the shortening can be in great part overcome.

Fig. 121.—Thomas's knee splint.

If, on the other hand, non-union has resulted, and a false joint is present, an appropriate operation may prove successful.

Fractures of the Lower End of the Femur.

(See Plates LVIII, LIX, and LXIII.) The epiphysial line crosses the lower end of the femur, first above the most

prominent points of the condyles (see Plate LIX). We have to distinguish between (*a*) fracture of the femur just above the condyles, usually oblique; (*b*) true separation of the epiphysis; (*c*) oblique and T-fractures of the condyles; and (*d*) detachment of parts of the articular surface (Plate LXIII, fig. 1).

The number of fractures of the lower end of the femur is very much less than that of cases of fracture of the shaft above.

A. *Supra-condylar fractures.*—(See Plate LVIII.) As a rule we have to deal here with a transverse, but occasionally an oblique fracture, and sometimes with a spiral or longitudinal one due to twisting of the bone.[1]

When the fracture is transverse or somewhat oblique, the displacement of the lower fragment is very typical, the powerful gastrocnemius tending to flex this portion of the bone towards the popliteal space, so that the upper fragment rides over the lower. In the diagnosis we have not only the shortening of the thigh, crepitus, and abnormal mobility, but the projection of the displaced fragment to help us. The knee-joint is often involved as a result of the injury. In the treatment the apparatus must be applied with the patient fully anæsthetised. Weight extension with direct pressure on the displaced lower fragment is employed. If the tendency to displacement is very marked, a suitable apparatus may be applied with the knee bent. One must not forget that the pressure of the displaced lower fragment upon the popliteal vessels and nerve may produce dangerous symptoms, and even gangrene of the leg.[2]

[1] It has been fully established, especially by the work of French surgeons, that spiral fractures may extend the greater part of the length of such bones as the femur and tibia, and that owing to the slightness or absence of displacement such spiral fractures have been thought to be rarer than they actually are. The general use of radiography will probably reveal, in many cases where a violent twisting force has been applied to a limb, the unsuspected presence of a spiral or longitudinal fissure. It may occur at all ages, even in early childhood, and is of considerable importance from the possible implication of an adjacent joint and from the crushing of the medullary tissue (risk of fat embolism, &c.). For an interesting review of the subject see H. Morris, 'Holmes's System of Surgery,' vol i, pp. 1021 (femur) and 1044 (tibia).—J. H.

[2] It is surprising that the writer dos not allude to the great value of division of the tendo Achillis in these cases. Weight extension can hardly

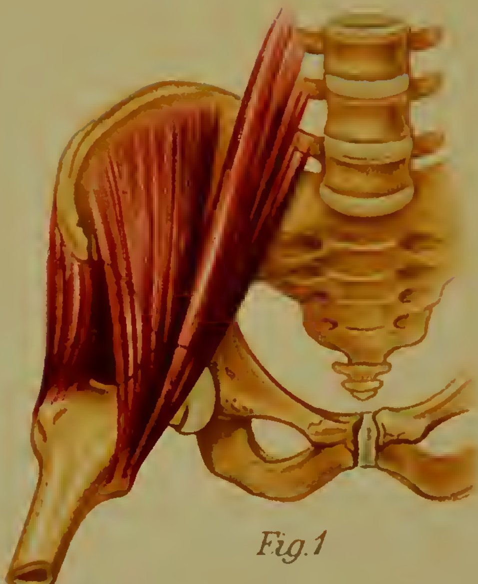

Fig. 1

Fig. 2

Fig. 2 a

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PLATE LVII.

FRACTURE OF THE FEMUR ABOVE ITS CENTRE—TYPICAL DISPLACEMENT.

Fig. 1.—Dissection showing the part played by the ilio-psoas muscle in producing flexion and abduction of the upper fragment.

Fig. 2.—Fracture of the right femur united with deformity, from a boy aged twelve. One observes the shortening of the right thigh causing obliquity of the pelvis, and the angular projection at the point of union.

Fig. 2 *a*.—Condition of the same patient after treatment. The femur was again fractured (by the osteoclast), and the thigh kept strongly flexed and abducted with weight extension, so as to prevent a recurrence of the deformity. It is now seen to be straight, and the shortening to be diminished.

Fig.1a

Fig.1

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PLATE LVIII.

TYPICAL DISPLACEMENT OF THE LOWER FRAGMENT IN A SUPRA-CONDYLAR FRACTURE.

Fig. 1.—Dissection of an artificially produced specimen of supra-condylar fracture, viewed from the inner and back aspects. The close proximity of the popliteal vessels, particularly the artery, to the sharp edge of the lower fragment, which is supposed to be tilted backwards by the calf muscles, is well seen, and hence the possible danger of gangrene of the leg. In fig. 1 *a* the bones alone are represented.

B. *Traumatic separation of the lower epiphysis.*—This injury is rarely observed, since the epiphysial disc is a very broad one, and on account of the small height of the epiphysis, great violence is necessary to detach it. For the most part the displacement tends to be the same as that of the supra-condylar fracture, but the periosteal sheath may prevent any displacement occurring.

Sometimes the epiphysis travels forward as shown in Plate LIX, fig. 4. This will depend upon the kind and direction of the acting force. There is nearly always extravasation of blood into the knee-joint. The symptoms include increased girth of the knee, tenderness over the epiphysial line, soft crepitus, abnormal mobility, especially felt when adducting or abducting the leg, and sometimes pronounced displacement.

Treatment.—After careful reposition under an anæsthetic, weight extension or a long splint is applied.[1]

do good, whilst the lower fragment is persistently tilted backwards, a condition only to be overcome by putting up the limb with the knee flexed, or by dividing the tendo Achillis.

In fracture of the femur towards the lower end the femoral artery may be damaged by either fragment, and its coats so bruised or torn that thrombosis with gangrene of the leg may result. Possibly when the fracture is put up there are few signs of such a serious injury having occurred; the absence of pulsation in the tibial vessels being of course a most suspicious symptom. A good example of injury to the femoral artery in Hunter's canal in the case of a simple fracture is recorded by Mr. Arnott ('Path. Trans.,' 1868, p 347).—J. H.

[1] There is no epiphysis of so much importance in practical surgery as the lower epiphysis of the femur. The grave results that have often followed its detachment, including injury to the popliteal vessels, suppuration involving the knee-joint, and arrest of growth, have led surgeons from the time of Sir Charles Bell to devote special attention to it; and I have collected records of no fewer than seventy-five cases, of which ten have not previously been published. The anatomy of the epiphysis is so well known that it need hardly detain us. We may only recall the facts that the epiphysis includes the whole articular surface, and that its separation must generally imply injury to the synovial membrane, that the adductor tubercle is placed exactly at the upper limit of the epiphysis, and that both heads of the strongest muscle in the leg—the gastrocnemius—are attached to the latter in great part. Hence the marked tendency to backward rotation of the epiphysis in cases of complete separation, and the necessity for the use of an anæsthetic before attempting reduction. Theoretically

c. *Oblique and T-fractures of the condyles.*—In these cases the joint is always involved. One or other condyle may

we might expect separation to occur even beyond the twentieth year; out of fifty cases three of the patients had attained that age, the average being ten years. The remarkable breadth of the femur at the epiphysial level and the great strength of the periosteum are circumstances which lessen the frequency of this accident. On the other hand, the attachment of the gastrocnemius, the popliteus, and the exceedingly strong ligaments of the knee, almost entirely to the epiphysis, favour its occurrence when a sudden wrenching force is brought to bear upon the leg. And it is nearly always a complicated and very violent force that has caused the separation of this epiphysis, such as hyper-extension with twisting or traction. Direct violence may suffice when the knee is run over, and it is remarkable how many cases have been due to the leg getting caught in the spokes of a wheel.

When experimenting on the bodies of young children (chiefly by abduction or adduction of the extended knee), I found—

1. That if the thigh were held high up, the femur usually broke at its narrow central part.

2. That if the lower third were firmly grasped, the epiphysis was usually separated.

3. When separation occurred the epiphysial disc almost always remained with the epiphysis, both heads of the gastrocnemius also remaining attached to it, and that the periosteum was extensively stripped from the lower third of the femur.

4. It was far easier to separate this epiphysis than to rupture the ligaments of the knee, or to break the shaft in its lower third.

The latter deduction has an important bearing upon the expediency of performing osteoclasia for genu valgum—an operation largely advocated in France, and advised in certain cases by such authorities as Macewen and Ogston (who has performed it over thirty times).

Now no surgeon would endorse this proposal if there were decided risk of detaching the epiphysis, with possible or probable arrest of growth. The dangers attending an aseptic division of the femoral shaft are as nothing compared with ultimate shortening of the limb to the extent of four, three, or even two inches. Putting aside the experiments on the dead subject, the following case sufficiently proves the truth of my contention. A distinguished French surgeon, M. Delore, a great advocate of osteoclasia, and who denied the risk of separation of the epiphysis in this operation, performed it on both sides on a child aged seven. The patient died of measles three weeks later, and M. Barbarin had the curiosity to dissect the limbs. On both sides the femur had given exactly at the epiphysial disc Chauvel records an example of separation of the epiphysis in the attempt to straighten an ankylosed knee; Callender in flexing a stiff knee; Volkmann knew it occur three times during the surgeon's manipulation of children affected with old hip disease. As is the case with the lower epiphysis of the radius and the upper one of the humerus, separation is remarkably clean, occurring exactly at the epiphysial disc, and a division of

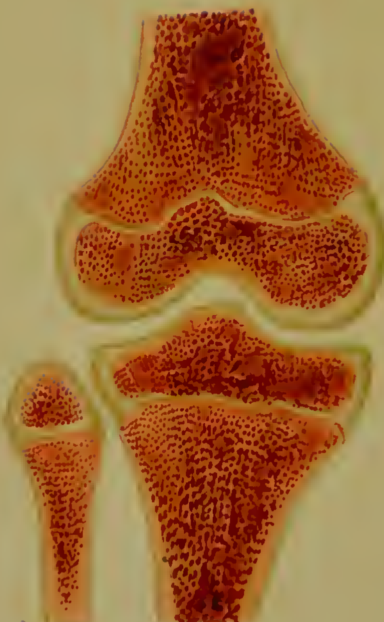

Fig. 1

Fig. 2

Fig. 5

Fig. 3

Fig. 4

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PLATE LIX.

Figs. 1 and 2.—The epiphyses about the knee-joint in a boy aged seven are shown in transverse and antero-posterior section.

Fig. 3.—Side view of the lower end of the femur, showing its epiphysis.

Fig. 4.—Traumatic separation of the lower epiphysis with backward projection of the diaphysial end. (From specimen in R.C.S. Museum, London.)

Fig. 5.—Oblique fracture separating the inner condyle of the femur (after Anger).

be broken off, or a T-fracture produced exactly analogous to that of the lower end of the humerus.

the condyles by a vertical split is a rare complication. The epiphysis may be completely separated, and yet retained in place by the periosteum ; how often this happens without being diagnosed we can only surmise.

When the diaphysis is forced through its sheath the varieties of displacement are many, though in the great majority of cases the epiphysis is carried forwards, and the danger of stretching the popliteal vessels over the broad diaphysial end is only too obvious. It is probable that in many of these cases the periosteum in front is not torn. Next in frequency to the displacement forwards of the epiphysis comes a lateral one, especially in the outward direction, sometimes so extreme that the leg and thigh form a right angle when seen from in front, or the deformity may resemble that of severe genu valgum. The epiphysis may be rotated on itself as well as laterally displaced, and in one remarkable case operated on by Mr. Atkinson, of Leeds, it was displaced right in front of the diaphysis, and so twisted that one condyle lay vertically above the other. In one reported by M. Trélat, union occurred with the epiphysis rotated through 90° on a vertical axis.

In order to explain the frequency with which displacement has been allowed to remain, or with which a wholly wrong diagnosis has been made, we must remember that the knee-joint may be distended with blood and synovial fluid, and there may be much swelling of the soft parts at the time the patient is seen by the surgeon. Not infrequently the diaphysial end has been mistaken for the condyles and a dislocation diagnosed, even in compound cases. One thing is, however, certain, that a correct knowledge of the pathology of separation of this epiphysis would have saved the patient and surgeon from many a disastrous mistake. The gravity of the lesion is best shown in an analysis of recorded cases. Taking first those uncomplicated by wound, out of 28 cases 16 were got into good position and recovered with very useful or perfect limbs (the possibility of ultimate shortening is not now considered), whilst of the remaining 12 in which perfect replacement was not obtained, 6 were followed by sloughing or suppuration. In 4 of these amputation had to be performed, 1 recovered after excision of the knee, and 1 after resection of the diaphysial end. In one case a popliteal aneurysm formed twenty years after, and led to amputation. The remaining cases recovered with more or less useful limbs, the displacement persisting. The cases complicated from the first with wound and more or less protrusion of the diaphysis gave still less favourable results. Out of 30 cases, 4 died from shock, &c., in 8 reduction was more or less effected, with 4 subsequent amputations and 3 deaths from pyæmia. The remaining case recovered after suppuration and some necrosis—a truly dismal record. In 13 cases amputation was performed soon after the injury, with at least 3 deaths (in one the limb was removed at the hip-joint).

In favourable contrast to this list, which is anything but creditable to

Diagnosis.—There is increase of width at the knee, pain on pressure about the condyles, lateral mobility with crepitus, effusion of blood into the knee, and the sharp projections of bone may be felt.

Treatment.—Since the injury may result in a kind of genu valgum or varum, great care must be taken in putting up the fracture; weight extension is best employed with compression of the joint (if necessary aspiration), and an early commencement of massage and passive motion.

D. *Fracture of parts of the articular surface.*—Excluding rare cases in which the attachment of either lateral ligament is dragged off with dislocation of the knee, we have to notice detachment of pieces of the cartilage-covered condyles. These are purely intra-articular injuries, which are dealt with later.

surgery, are the cases in which the protruding end of the diaphysis was cut off and replacement effected, five in number, all of which recovered with useful limbs. It may be said that after resection of the end of the protruding diaphysis all growth at the affected part will cease. This is by no means certain, and the following case, proving the contrary, is of such interest that a brief quotation will be excused.

I. A boy, aged eight, in climbing behind a carriage, had his right leg caught in the wheel. When examined by M. Delens the diaphysis protruded through a wound on the outside of the popliteal space. Prolonged efforts at reduction under chloroform failed on two occasions, but after the end of the bone had been sawn off replacement was easily effected. At the end of a fortnight the splint had to be removed on account of an abscess forming; this was drained and slowly healed. At the end of fourteen weeks good union had occurred, but with some stiffness of the knee and 4 cm. shortening. He was repeatedly examined during the next ten years, and at the age of nineteen the joint was freely moveable, and the shortening amounted only to 9 cm. This proves that a considerable amount of growth had occurred at the lower epiphysial disc, since the failure amounted only to 5 cm. in the ten years.

Treatment.—It has been noted that the most common displacement is that of the epiphysis forwards and the diaphysis backwards into the popliteal space. In order to effect reduction complete anæsthesia should be induced, and the knee fully flexed so as to make the heel touch the buttock. It is surprising with what comparative ease the epiphysis slips back into place by this method. The limb should be kept flexed by means of a bandage without the use of a splint, and simply resting on a pillow for two or three weeks, and then gradually brought down to the extended position by means of a Macintyre splint.—J. H.

Fig. 1

Fig. 4

Fig. 2

Fig. 3

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PLATE LX.

DISLOCATIONS OF THE PATELLA.

Fig. 1.—Dissection of an outward dislocation of the patella, the articular surface of the latter facing directly the outer condyle.

Fig. 2.—Dissection of a vertical dislocation of a patella; in fig. 3 the latter bone is completely twisted round.

Fig. 4.—View of outward dislocation of the right patella from a man aged twenty-nine. The knee is strongly flexed, and the projection of the patella at its outward side is well seen.

Dislocations of the Knee.

The leg may be dislocated *forwards* during hyper-extension, with rupture of the lateral and crucial ligaments, *backwards*,

FIG. 122.

FIG. 123.

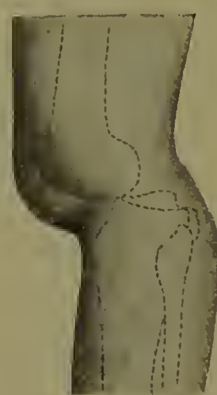

Fig. 122.—Forward dislocation of the leg.
Fig. 123.—Backward dislocation of the leg.

and *laterally* in either direction. In all these varieties, which are extremely rare, the condyles of the femur can be felt more or less plainly in their abnormal position. Owing to the great force which is necessary to produce these dislocations, it is readily understood that the injuries may be complicated; injury to the popliteal vessels and persistence of the dislocation may lead to gangrene of the leg, and the knee-joint is invariably much damaged and certain to inflame. Reduction is, as a rule, easily accomplished by traction and by direct pressure.

Dislocations of the Patella (see Plate LX).

The patella is not firmly fixed at its sides, being only a sesamoid bone developed in the quadriceps. Nevertheless it is but rarely dislocated, and most of the examples are in the outward direction. This is favoured by the normal position of the patella, which rests more against the outer than the inner condyle, especially if there is a tendency to genu valgum. The dislocation is incomplete if the joint surfaces

remain partially in contact, and complete when the patella rests wholly on the outer surface of the condyle. The dislocation may occur when the knee is extended, when the patella rides directly over the border of the femoral condyle, perhaps from strong contraction of the quadriceps, or during flexion when the bone slides in the groove between the femur and the tibia. The displacement is then probably due to a force acting directly on the bone from the inner side, as for instance from a blow against the knee of a rider. The diagnosis is easy, and reduction is effected by direct pressure with the knee extended and the hip bent, so as to relax the quadriceps.[1]

A vertical dislocation of the patella happens when the knee-cap is twisted through an angle of 90°, so that its border rests in the groove between the condyles. One speaks of an inward and an outward displacement according to whether the cartilaginous surface is directed towards the inner or the outer border of the joint. The former is slightly the more common. The injury usually occurs from direct violence, but is said to occur sometimes from muscular action. The position of the patella is readily felt. The bone may be completely twisted through an angle of 180°, so that its joint surface faces forwards. This injury is extremely rare, and its diagnosis may be attended with difficulty.

Fractures of the Patella (see Plates LXI and LXII).

These are far more common than examples of dislocation of the bone, and are chiefly observed amongst male adults under fifty years of age. The patella, like the rest of the

[1] Dislocation of the patella may become habitual in some subjects, and cease to cause any discomfort when it occurs. A woman under my care for another complaint dislocated her right patella on to the outer surface of the outer condyle every time she bent the knee. Sir Astley Cooper mentions a similar case (but symmetrical) in a girl who had been brought up as a street dancer (Cooper, 'Fractures and Dislocations,' p. 8). Contortionists and others who have habitually stretched their ligaments during early childhood provide examples of this recurrent dislocation; as also do those who have had the ligaments relaxed by long-continued distension of the knee from synovitis.—J. H.

Fig. 2

Fig. 3

Fig. 1

PLATE LXI.

FRACTURE OF THE PATELLA.

Fig. 1.—Specimen of a complete transverse fracture of the patella with extensive rent of the lateral expansion of the quadriceps. The fibrous aponeurosis covering the front of the patella projects between the bony surfaces in shreds.

Figs. 2 and 3.—Transverse fracture of the patella without any tearing of the lateral expansion, and hence with no separation of the fragments.

Fig. 1

Fig. 4

Fig. 3

Fig. 5

Fig. 2

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PLATE LXII.

FRACTURE OF THE PATELLA.

Fig. 1.—The right leg of a man with old transverse fracture of the patella united by fibrous tissue; a deep groove is seen between the fragments.

Fig. 2.—A young man with symmetrical fracture of the patella from a fall on to both knees. Eight weeks after the injury massage of the limb was begun, and the drawing shows that the patient was subsequently able to raise one limb from the bed, and maintain it in a position of almost full extension; this in spite of the marked separation between the fragments. Since, however, no further improvement was likely to take place, I performed the operation of suture on both sides with favourable result.

Figs. 3 and 4.—Specimens of transverse fracture of the patella united by bands of fibrous tissue (from the R.C.S. Museum).

Fig. 5.—Specimen of stellate fracture, the fragments being bound together by callus, with hardly any displacement.

knee region, is much exposed to injury. It may break from direct violence, due to a fall on to the knee or the impact of a heavy weight. These direct fractures tend to take a stellate form, the bone being splintered in more or less radiating lines, the fragments remaining as a rule close together. From direct violence also we may have an oblique, a longitudinal, or a transverse fracture.

The fractures from indirect violence include those due to muscular contraction. It is a popular saying that a drunken man in falling seldom or never breaks his knee-cap, since he falls like a sack to the ground. Under ordinary circumstances in falling one makes consciously, or as a reflex act, a sudden contraction of the quadriceps muscle which fixes the patella, and may fracture the bone over the end of the femur as the knee is bent. Thus results a transverse fracture across the centre, or somewhat below this point. No doubt the size of the patella, which varies in different individuals, and its degree of fixation, are of importance in the production of a fracture. As a rule the strong aponeurosis in which the patella lies is extensively torn in indirect fracture, more so than in that by direct violence, unless in the latter form the knee is forcibly bent after the bone has given way. On the amount of this tearing of the lateral aponeurosis largely depends the degree of separation of the fragments. (Compare Plate LXI, figs. 1 and 2.)

The proportion of indirect fractures has been over-rated; Bähr estimates it as only about 20 per cent., though the grounds for determining this are not very certain. The force which leads to an indirect fracture of the patella might produce instead rupture of the quadriceps tendon or of the ligamentum patellæ, but neither of these are nearly so common. The symptoms are very simple if the fracture runs through the middle of the bone, and is attended with separation of the fragments. Since the bone is embedded in the joint capsule the injury necessarily involves an opening into the joint with extravasation of blood therein. This extravasation of blood may completely fill the joint. In recent cases, as a rule, one can bring the fragments together and produce crepitus. If only a small piece of the patella is torn off, and especially if the periosteal investment

of the bone is fairly intact, the diagnosis may be rather more difficult. However, on careful examination, lateral movements of the fragments, alike in recent and old cases, can almost always be obtained.

The prognosis of fractures of the patella depends chiefly upon the kind and severity of the injury (whether transverse or stellate fracture, and whether it is accompanied by extensive tearing of the lateral part of the aponeurosis), and upon the nature of the treatment. The fracture from direct violence as a rule gives the best result.

Since after a fracture of the patella the strength and in a less degree the mobility of the knee is often permanently diminished, the impairment in capability for working must depend to a considerable extent upon the patient's occupation. Persons with some light occupation in which, for instance, they have mainly to sit at their work, are but slightly incapacitated, and I know officers in the army who can carry out their duties in spite of ligamentous union of such fractures. Working men as a rule suffer considerably in their occupation from fractures of the patella. Even though the power of extension is completely, and that of flexion nearly completely recovered, the knee-joint and lower limb remain in most cases weaker, and less fitted for active work.[1]

Bähr found in examining forty-four old cases of fracture of the patella (which averaged four years from the date of injury), that in forty-two some weakness remained, and he estimated this impairment at about 35 per cent. of the working power.

[1] It seems impossible to predict the final amount of usefulness of the limb in a case of fractured patella which unites with marked separation of the fragments. The following two cases illustrate this well.

1. A man aged 17. Fracture resulting in nearly three inches of separation, and of course wasting of the quadriceps. When examined a few years later the limb was so useful that he had recently walked from London to Brighton in a day.

2. A woman broke her right patella at the age of fifty, with the result of three inches separation between the fragments. When examined eighteen years later she had no power of extending the knee, had been obliged to walk with crutches ever since the accident, and considered the limb practically useless.—J. H.

Treatment.—With no other fracture does one observe so many instances in which with wide separation very fair function of the limb is retained, and on the other hand so many in which with excellent position of the fragments severe and persistent limitation is present. This no doubt depends largely on the condition of the quadriceps muscle, which in many cases shows signs of marked atrophy, and this atrophy may first come on some little time after the injury. The explanation of the atrophy is partly from prolonged disuse, but still more from reflex influence of the spinal cord centre. To counteract this tendency it has been lately proposed that in the treatment daily massage of the muscle should be carried out, the direction of the rubbing being always towards the knee, which is of course kept extended whilst the hip is flexed. Although undoubtedly useful, this measure must yet be considered as a somewhat one-sided treatment, and it should certainly not prevent the attempt to keep the fragments closely in contact. The causes for the unfavourable results after healing of fractures of the patella are multiple. The contraction of the quadriceps, the atrophy of this muscle, the effusion of blood into the knee-joint, which separates the fragments, the low degree of vascularity of the patella and its slight tendency to form new bone must be mentioned. Of still greater importance is probably the interposition of bands of the aponeurosis derived from the front of the bone, which favours ligamentous union even if they are kept close together.

In order to fulfil these indications the hip is bent and the knee fully extended, so as to relax the quadriceps. A back splint is applied, made, for instance, from poroplastic felt moulded to the part; if necessary the effused blood is let out by puncture, the fragments are brought together, and the torn aponeurosis displaced as far as possible by rubbing them one on another. Bands of strapping fixed to the splint are made to press the fragments in apposition. Once or twice every day the quadriceps has massage, and less frequently the weak faradic current applied to it. When the patient is discharged he must continue for some months with the use of a leather knee-cap, whilst every day practising slight passive and active motion of the joint. Without doubt

the closer the fragments can be brought together, and the more firmly they unite, the better as a rule will be the ultimate function. A patella united only by ligament, even though there is little separation, never gives the normal stability in the limb. For this reason many surgeons advocate operation as a primary measure of treatment. Many forms are employed; thus, for instance, two needles are passed transversely through the quadriceps and through the ligamentum patellæ, and approximated by silk threads, or a silver wire may be passed subcutaneously around both fragments in the vertical direction. Malgaigne's hooks are now hardly ever used. On the other hand, primary direct suture of the fragments, which involves opening the joint, finds more and more advocates, though it should be done only by skilled surgeons. I have myself carried this out when the simpler treatment with splint, massage, &c , had not led to the desired result, and with considerable success.[1] As particularly unfavourable

[1] The question whether a recently fractured patella should be operated on or not is a most difficult one. Various methods of subcutaneous "suture" have been introduced, of which probably the best is that advocated by Mr. A. E. Barker, which consists in tying the two fragments together by aseptic silk ligature, which passes right round them in the vertical direction, and is left permanently in. The ligature is introduced on a curved needle mounted on a handle, and rests against the articular cartilage and the subcutaneous surface of the bone. It may, however, be said that most surgeons, if they operate at all on fractured patellæ, prefer to expose the line of fracture by an open incision, to thoroughly remove all blood-clot, to lift up and cut off the shreds of aponeurosis that almost invariably dip down between the fragments, and then secure the latter in firm apposition by one or two loops of stout silver wire introduced by means of a drill, the wire being twisted up tightly, and its ends lightly hammered down level with the surface of the bone. The wire should just avoid the articular cartilage, and by being introduced very obliquely should get a firm grip of each fragment. It remains permanently in place unless it later on cause irritation and require removal (which, it may be remarked, is no easy matter). If asepsis has been secured, and in no other operation are such elaborate precautions called for in disinfecting the skin, &c., the ultimate result is generally extremely good. The patient is able to bend the knee within a few weeks of the operation, he need wear no cumbrous knee-cap, the fracture unites by bone (though probably no bone forms callus with more slowness than the patella), and there is little risk of re-fracture. But owing to the unfortunate results which have occurred from time to time due to septic inoculation at the time of operation, and also to the very fair results which are seen from the non-operative treatment, wiring the frag-

complications of the fracture we may note complete absence of any union and coalescence of the upper fragment with the anterior surface of the femur, a condition which is observed in old cases not very infrequently; every attempt at flexion then naturally causes separation of the fragments, &c. Stretching of the ligamentous union and even re-fracture of the bone are not very uncommon.

Other Intra-articular Injuries to the Knee-joint.

A. *Detachment of part of the articular cartilage from the femur* (Plate LXIII, fig. 1).—It is well known that the knee-joint is not a simple hinge one, and during flexion a fair amount of rotation of the leg together with ab- or adduction can be effected. During these movements the crucial ligaments and the semilunar cartilages are of great importance. If when the knee is bent the bones are pressed together, with lateral twisting, a portion of cartilage, with the adjacent spongy bone, may be forced off the end of the femur. The force which produces this is often surprisingly small, and may be, for instance, only an unexpected movement of the knee. The edges of the detached piece of cartilage are sharply cut, and its size may be that of a bean or almond.

It is possible to produce this lesion by experiment on the dead subject. The detached portion may be completely loosened and form at once a foreign body in the joint; probably there are also cases in which it remains for a time still connected with the rest of the bone, and only forms a "loose cartilage" in process of time as a result of recurrent pressure and active movement; the loose cartilage must naturally be removed by operation according to surgical rules.

ments, so far from having become the routine practice, is apparently less in favour than it was a few years ago. Thus out of forty cases of recent fracture of the patella treated at one of the largest general hospitals in London last year, only two were operated on, though the result in these two left nothing to be desired. The surgeon who does perform the open operation will, I think, be convinced that no other method is likely to obtain such complete apposition of the fragments and such firm union, but whether the risk of the operation is justified or not is still an open question. If wiring be decided on, a few days should always be allowed to elapse after the accident in order that the inflammatory reaction may subside, and the skin over the joint may be rendered thoroughly aseptic.—J. H.

B. *Injury to the semilunar cartilages* (Plate LXIII, fig. 2).—Under this heading come dislocation and rupture of the semilunar cartilages, which accidents may occur as independent injuries.

In 1892 Bruns was able to collect forty-three cases. The internal semilunar cartilage is concerned twice as often as the external one; usually the attachment of its anterior end is torn, but the cartilage is very rarely completely detached or divided in its continuity. In the production of this accident strong rotation of the lower end of the femur when the knee-joint is bent usually occurs, and it is exceptional for it to happen in a perfectly sound normal joint; for this reason the injury is most frequently observed in England among foot-ball players and the like.[1]

Symptoms vary in intensity, but there is always marked pain felt on pressure on the side of the joint concerned. The latter is slightly flexed and cannot be fully extended, and there is effusion into it.

In cases where the displacement has occurred over and over again, the pain and impaired mobility become lessened in degree. Objective examination frequently reveals a flat moveable body, which during extension projects at the fore part of the inter line and in flexion disappears. As it moves forwards and backwards a sort of snap may be felt by both surgeon and patient. When the detached end of the semilunar cartilage remains in the centre of the joint the inter line may simply be more hollowed and painful to pressure than normal, but if there is much effusion the diagnosis may be impossible, and it is generally very difficult, from the cases of loose cartilage (foreign body).

Treatment.—In recent cases reposition and moderate pressure, and later the use of plaster-of-Paris bandage in extension, with subsequently the continued use of a light

[1] In violent flexion of the knee-joint the force exerted through one of the crucial ligaments may tear off a piece of bone from either the tibia or the femur. In a remarkable case recorded by Mr. Erichsen a boy fell a considerable distance with both knees flexed. At the post-mortem it was found that on one side the anterior crucial ligament had torn away part of the tibia, on the other side its attachment to the femur, *i. e.* part of the external condyle. In such cases there is sure to be much effusion of blood into the knee-joint, with probably much impairment of mobility.—J. H.

Fig. 4

Fig. 3a

Fig. 3b

Fig. 1

Fig. 2

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PLATE LXIII.

Fig. 1.—Traumatic detachment of a fragment of bone and cartilage from the inner condyle of the femur.

Fig. 2.—Rupture of the internal semilunar cartilage.

Figs. 3 *a* and 3 *b*.—Fracture from compression of the upper end of the tibia due to a fall from a hay wagon, in which the femoral condyles and the tibia were driven together. The patient, a young woman, died of acute sepsis resulting from a spiral fracture of the same tibia in its lower part (see Langenbeck's 'Archives,' vol. xli, p. 357).

Fig. 4.—Fracture of the left tibia just below the head of the bone united with deformity; it was due to direct violence.

knee-cap, should be employed. In old and recurrent cases the cartilage may be fixed by deep sutures, but this is a somewhat dangerous proceeding, and the best course to adopt is the excision of the cartilage concerned, which seems to have but little effect on the subsequent use of the joint.

Fracture of the Bones of the Leg at their Upper Ends.

A. *Fracture from compression of the tibia through its articular surface* (Plate LXIII, fig. 3; Plate III, fig. 1).—This fracture results from violent pressure of the tibia against one or other condyle of the femur; as, for instance, by a fall from a considerable height on to the feet. Cases have occurred in mountain climbing, in a fall from a wagon, and I have even known it result from jumping off a bicycle. There may be simply a fissure traversing the joint surface, or in bad cases the joint end of the tibia may be crushed into two or more fragments, between which the shaft is impacted.

There will be first extravasation of blood into the joint, and later considerable synovitis; movements of the joint are painful, and perhaps abnormal lateral mobility can be obtained. The upper end of the tibia may be increased in width, and is very painful to pressure. If the fracture involves only one half of the tibial surface there may be a tendency to varus or valgus, the former being most frequent owing to the inner tuberosity of the tibia being most often involved. There is considerable risk of arthritis deformans supervening. In the treatment weight extension should be employed, with, if necessary, lateral traction to correct the varus or valgus.

Massage and passive motion of the knee-joint should be employed as soon as practicable.

B. *Fracture of the tibia below the tuberosities.*—This form is rare, and results, as in the case shown in Plate LXIII, fig. 4, from direct violence, such as a kick, or more rarely from such an indirect force as might lead to a fracture of the lower end of the femur or a dislocation of the knee. The line of fracture may be quite oblique, and may enter the knee-joint, causing effusion into the latter.

The diagnosis, which depends chiefly on the increased

width of the bone, its tenderness on pressure, and the abnormal mobility, can only be made out under an anæsthetic. The best treatment consists in weight extension, with the injured region left exposed, so as to render massage and compression by bandage possible. It may be necessary to correct the tendency to varus or valgus.

C. *Traumatic detachment of the upper epiphysis of the tibia.*—This injury is rare, but its possibility must be considered in any case of severe injury to the region of the knee-joint in a child. A correct diagnosis is only possible under an anæsthetic, when abnormal mobility and cartilaginous crepitation may be ascertained.

D. *Detachment of the anterior tuberosity of the tibia.*—This is a very rare injury. It nearly always involves the knee-joint; the fragment of bone which is drawn upwards by the quadriceps can be felt to be moveable in all directions, and active extension of the knee is impossible. The best treatment consists in fixing the fragment in place by a steel nail, with the joint in the extended position.

Fracture of the Upper End of the Fibula.

The head of the fibula may be broken off by direct violence (for example, by a kick or fall, or by a strong contraction of the biceps muscle). The external popliteal nerve may be damaged at the same time. The upper fragment is not always displaced, but should it be so, fixing it with silver wire will probably give the best result.

Fracture of both Bones through their Shafts.

This injury is very common, resulting usually from direct violence (being run over, &c.). In such cases both bones are probably involved about the same level.

If from indirect force, and particularly from a violent twist of the leg with the foot fixed, the tibia will give way towards its lower end obliquely, whilst the fibula, being unable to support the weight of the body alone, bends and breaks at a higher level. Naturally the cases of oblique fracture are attended with more risk of overlapping and

Fig. 4a

Fig. 4

Fig. 3

Fig. 2

Fig. 1

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PLATE LXIV.

FRACTURES OF TIBIA AND FIBULA.

Fig. 1.—United fracture of both tibia and fibula at about the same level; marked lateral displacement, with union of all four fragments together.

Fig. 2.—Specimen of a united fracture of the lower third of the tibia and the upper third of the fibula.

Fig. 3.—Guide to determining the correct position of the limb after fracture, showing that a line drawn from the anterior superior spine to the great toe passes through the patella at about its centre.

Figs. 4 and 4 *a*.—Isolated fracture of the tibia in its upper third, with upward dislocation of the fibula. In the case represented by fig. 4 there was shortening of 3 cm.

defective union than those of transverse fracture. The sharp lower end of the upper fragment is apt to project under the skin, and may perforate it.

The diagnosis is usually easy, although the exact position at which the fibula breaks may be uncertain, unless the Röntgen rays are employed. Any degree of twisting of the lower fragment can be determined by following with the finger the exact line of the tibial crest.

In examination for abnormal mobility an assistant should fix the knee-joint with his hands, whilst the surgeon, placing one hand over the supposed site of fracture, grasps the foot with his other hand and moves it in the direction of ab- and adduction. If the diagnosis is still difficult, it may be advisable to rest the upper fragment firmly against some part of the surgeon's body—such as his thigh—whilst fixing it with the left hand, and then, with the right hand grasping the foot, to try for abnormal mobility.

Treatment.—The tendency to overlap of the upper fragment (much more rarely of the lower fragment) can nearly always be overcome by direct traction and manipulation; though if the fracture be oblique, displacement readily occurs.

Great care must be exercised in order to obtain the best possible position of the fragments. With this object the relation of the foot and leg on the affected side to the horizontally placed patella should be compared with that present in the opposite limb. The statement that the anterior superior spine, the inner border of the patella, and the inner edge of the great toe lie in the normal subject in one straight line is not wholly true (see Plate LXIV, fig. 3). In putting up the limb the knee must be extended and the foot placed at a right angle, and there is nothing better during the first week than back and side splints. At the end of this time I believe it is best in many cases to readjust the limb in well padded plaster-of-Paris splints, and sometimes an anæsthetic should be given for this. This proceeding should be repeated after another eight days or so have elapsed, when an ordinary plaster-of-Paris bandage may be employed.

Lateral deviation can in this manner be easily prevented, but it is more difficult to prevent a tendency to inward rotation of the lower fragment, especially if the fracture is

situated towards the upper end of the shaft. Care also must be taken lest some backward bending at the seat of fracture should occur (see Fig. 124). It will be readily

FIG. 124.

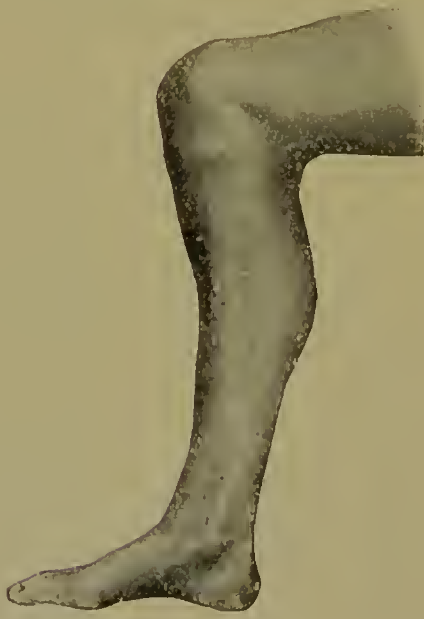

FIG. 125.

Fig. 124.—Fracture of the leg united with backward curve.
Fig. 125.—Lateral bending of the leg after union of a fracture.

understood how likely this is to happen when the plaster of Paris is applied early and the limb supported by the assistant's hands above and below the line of fracture. The use of weight extension, elevation of the limb from the cradle with relaxation of the calf muscles by flexion of the knee, will usually suffice to correct any tendency to overlap of the ends of the bone. Is it advisable to apply plaster-of-Paris bandages soon after the accident in a case of fracture of the tibia and fibula? The answer to this question is that many surgeons have found this method of treatment more convenient than any other. I would, however, refer the reader to some remarks on the subject in the early part of this book. The immediate application of plaster-of-Pa ris band

ages requires much technical skill and constant supervision, and in some cases considerable risk is run. The sooner the fracture is seen by the surgeon the safer it is to apply plaster-of-Paris bandages, whilst the swelling is but slight, and whilst an exact reposition can be secured; whereas after one or two hours have elapsed there is greater difficulty or more risk.

It may be said, finally, that it is only justifiable to employ the immediate application of plaster of Paris in these cases when the surgeon is experienced in its use and is able to supervise the patient from day to day.

After union has taken place, baths or douches to the limb, with massage over the muscles and active and passive movements of the adjacent joints, may be employed. If a conspicuous or painful projection of bone remains at the site of fracture, it should be removed with the chisel after the bone has been exposed by turning up a small flap.

The prognosis of this form of fracture depends almost entirely on the treatment. If this is properly carried out and there are no complications, complete restoration of function should occur. Experience, however, shows that this result is not obtained at the present day in 50 per cent. of the cases, since deformity at the site of fracture, œdema of the leg, stiffness of the adjacent joints, &c., frequently result and impair the capacity for work during long periods of time or even permanently.

The Ambulatory Treatment of Fractures of the Leg.

In the course of the last few years attempts have been revived to treat cases of fracture of the tibia and fibula with some apparatus that will allow of the patient getting about during the whole progress of the treatment. Some modification, for instance, of Thomas's splint, by which elastic extension is provided to the foot and the patient bears the weight of his limb on the tuber ischii, is suitable for this method. Some recommend plaster-of-Paris bandages or splints which only immobilise the leg and foot whilst leaving the knee-joint free. In any case the apparatus must be applied when all displacement is completely overcome, and it

must be strong enough to prevent its recurrence whilst the patient moves about. It is wise to renew the apparatus

Fig. 125A.—Old ununited fracture of tibia with compensatory hypertrophy of the fibula, which had become abnormally curved outwards owing to the weight transmitted through it. The patient had been able to walk. From Sir Astley Cooper.

once or twice. I am still of opinion that the ambulatory treatment is not suited for general practice, although it may now and then give satisfactory results.

A. *Fracture of the tibial shaft alone* (Plate LXIV, figs. 4 and 4 *a*).—It has been already noted that fracture of both bones of the leg is often in the first instance of the tibia alone, the fibula giving way secondarily. The same thing

Fig. 1

Fig. 2

Fig. 3

Fig. 4a

Fig. 4b

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PLATE LXV.

FRACTURES OF TIBIA AND FIBULA.

Fig. 1.—Longitudinal or spiral fracture due to torsion of the lower third of the tibia. From the same case as that represented in figs. 3 *a* and 3 *b*, Plate LXIII. It will be noted that the fracture extends into the ankle-joint.

Fig. 2.—Fractures from torsion of the lower part of the tibia.

Fig. 3.—Badly united fracture in lower third of both bones, with displacement of the foot in the direction of pes valgus.

Figs. 4 *a* and 4 *b*.—Fracture above the malleoli united with marked deformity (pes varus). A normal leg is shown for comparison.

may happen during osteoclasis, from torsion, and from forced bending of the leg.

Fracture of the tibia alone may result from direct and indirect violence, and if it be oblique the diagnosis may be easy owing to projection of one fragment, even although the fibula is intact and acts as a splint. The diagnosis is difficult if the fracture be transverse; in the want of other symptoms, a kind of cracking or snapping sound with forced movements, together with pain on pressure and percussion, may be useful. Very marked deformity at the site of the tibial fracture is always accompanied either by fracture or dislocation of the fibula. In the treatment a perfect reduction and retention in good position is more readily obtained than in the case of fracture of both bones, and plaster of Paris or the "ambulatory treatment" may be used with less risk.

B. *Fracture at the lower end of the tibia and fibula.*—These fractures are generally the result of forcible lateral movement of the foot, either outwards or inwards, complicated sometimes by a twisting or rotation of the foot. Fracture just above the malleoli deserves special notice, since it resembles the supra-condylar fractures at the lower end of the humerus, and also from the marked tendency to union with deformity, such as is shown in Plate LXV, figs. 3 and 4. Besides the curvature here illustrated, the lower fragment may be displaced backwards. Since marked deformity is usually present from the first, the diagnosis is easy.

Fig. 126.—Extension and counter-extension applied to the leg with pressure exerted on the upper fragment by means of a weight.

In putting up the fracture the surgeon must guard against over-correction, and especially against the tendency of the foot to be displaced backwards.

In old cases which have united with marked deformity and disturbance of function, the only thing that can be done is osteoclasis or osteotomy.

Pott's fracture (see Plates LXVI and LXVII).—As is well known, this may result from violent inversion or more commonly eversion of the foot. Both methods can be illustrated on the dead subject, and it is hardly necessary to go into details on the diagnosis of this very frequent and well-known injury. It involves, of course, opening the joint, and is doubly important since this joint has to bear the whole weight of the body. We see even at the present time great errors made sometimes in the treatment, errors which cripple the capacity for work of the patient for his whole life.

The anatomical conditions involved in this fracture are worthy of special note. The fragment broken off the inner malleolus is sometimes quite small. The inward bend of the fibula leading to its fracture is hardly possible without a tear of some of the strong ligamentous bands passing between the two bones at their lower end.[1] A small part of the tibia or fibula surface may be torn off as shown in Plate LXVI,

[1] *Dupuytren's Fracture.*

A rare but interesting variety of fracture at the ankle-joint is that first described by Dupuytren, in which together with detachment of the internal malleolus and fracture of the fibula about three inches up, the astragalus acting as a wedge forces apart the lower ends of the two leg bones. In order that this should occur the very strong inferior tibio-fibular ligaments must be torn or the adjacent outer edge of the tibia prized off. So much force is required to do this that this complication occurs not more often than once in 100 cases of Pott's fracture. Three specimens exist of it; one (figured by Sir Astley Cooper) in St. Thomas's Hospital Museum, a second by Mr. Thomson ('Brit. Med. Journ.' for 1880, vol. i, p. 919), and a third which I placed in the London Hospital Museum (see 'Path. Trans.,' 1888, p. 238). The remarkable ascent of the astragalus between the tibia and fibula and the consequent widening of the ankle make this form of fracture noteworthy, and although the displacement may be reduced by traction the ultimate result is not likely to be so good as that of an ordinary well-treated Pott's fracture. In several cases it is stated that the impaction of the astragalus could not be reduced, and the utility of the leg was consequently much impaired.—J. H.

Fig. 1

Fig. 2

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PLATE LXVI.

TYPICAL POTT'S FRACTURE.

The detachment of the internal malleolus and the fracture of the fibula a short distance above the ankle are seen in both specimens, which were obtained by experiment on the dead subject. The valgus deformity is also well shown.

In fig. 1 some separation of the lower ends of the tibia and fibula is seen.

Fig. 1

Fig. 2a

Fig. 2b

Fig. 3a

Fig. 3b

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PLATE LXVII.

FRACTURES ABOUT THE ANKLE-JOINT.

Fig. 1.—Normal epiphysial lines at the lower end of the tibia and fibula.

Figs. 2 *a* and 2 *b*.—Pott's fracture united with deformity (marked flat-foot).

Figs. 3 *a* and 3 *b*.—Pott's fracture with backward displacement of the foot.

fig. 1. It is clinically of importance to remember that some cases of Pott's fracture may be able to walk, though with a limp, shortly after the accident.

Figs. 127 and 128.—Compound Pott's fracture in a woman aged forty-five. After enlarging the wound the fragments were replaced, and under antiseptic treatment a good result was obtained.

Treatment.—It is all-important to obtain an exact reposition. It used formerly to be advised that the eversion of the foot should be over-corrected; in other words, a splint applied with the ankle strongly inverted. This, however, is not necessary, provided the eversion is overcome as well as the tendency to backward displacement. When effecting this the angular depression opposite the fractured fibula (see Plates LXVI and LXVII) disappears when the surgeon presses the two lateral surfaces of the ankle together. In a very complicated case I was obliged to fix the lower end of the fibula to that of the tibia with a peg. It is of great importance to place the foot at right angles to the leg, and otherwise in correct position. In the first few days wooden splints are best applied, then plaster-of-Paris bandage or lateral splints. During the first fortnight the apparatus

should be taken down every three or four days, so that the ankle may have massage and passive movement used to it, and also in order that the correct position of the ankle may be observed, for I have known in a case of Pott's fracture an excellent position obtained at first, and then spoilt by want of attention to the splints. Much later, when the fracture has united, it is advisable that the patient should wear a boot that is strengthened at the side by steel, so as to prevent the tendency to valgus.

Dupuytren's splint applied as shown in Fig. 129 is well adapted to correct this eversion of the foot. It will be seen in the illustration that the splint is applied on the inner side of the leg, and that the pad does not reach to the ankle-joint, so that the foot can be drawn towards the splint by turns of bandage. If the surgeon has to treat a case of this fracture which has united in bad position, it may be necessary to perform osteotomy of the fibula, and frequently also of the internal malleolus, in order to get the foot into good position. I have succeeded in several instances after doing osteotomy of the fibula at the old site of fracture in straightening the foot with Rizzoli's osteoclast; the after treatment must be the same as for a recent fracture.[1]

Fig. 129.—Dupuytren's splint applied to Pott's fracture.

c. *Fracture of both malleoli.*—If forcible adduction of the foot has torn off the external malleolus, it is possible

[1] The best operation to perform in these cases is not yet quite certain. *A priori* osteotomy of the fibula with forcible straightening of the ankle as described by the author might be expected to suffice, but whether it is from changes about the inferior tibio-fibular joint, or from overgrowth of bone about the internal malleolus, the fact is that this operation may almost entirely fail. On the other hand, an osteotomy above the ankle-joint through both tibia and fibula (one incision only being needed) gives on the whole better results, and has the advantage of not involving the ankle-joint. If necessary a thin wedge of the tibia should be removed. The eversion of the foot must be completely overcome, slight backward displacement is of comparatively little importance, and it is probably never worth while to operate for this alone.—J. H.

that the foot may be driven against the internal malleolus and break that also. This injury is, however, very uncommon, and we need only allude to it here together with other rare forms, such as a vertical fracture through the tibia caused by violent twisting of the foot. Careful examination will enable a satisfactory diagnosis to be made in most of these cases, and the treatment does not differ from that required in other forms of fracture above the ankle.

D. *Separation of the lower epiphysis of the tibia* (see Plate LXVII, fig. 1).—This is a rare accident, which can naturally only happen to young subjects. It has been several times observed during forcible rectification of bad cases of club-foot. Abnormal mobility and cartilaginous crepitus are the chief signs of its occurrence.

The lower end of the tibia or fibula may alone be fractured by moderately severe indirect or direct violence, and the diagnosis may offer some difficulty. Pain on pressure or on ab- or adduction of the foot are perhaps the chief signs, and doubtful cases should be treated as though there were a fracture, after the method already described.

The Foot.

The movements of the foot, as is well known, take place, so far as flexion and extension are concerned, mainly at the ankle; as regards inversion and eversion, chiefly in the joints between the astragalus and the other bones.

It is obvious that exaggeration of these motions may lead to dislocation in the respective joints.

A. *Dislocation at the ankle-joint* (see Plate LXVIII).—As shown in the illustration, the foot may be dislocated either forwards or backwards; its position is so characteristic that no difficulty can be experienced in making the diagnosis, and reduction may be effected by direct pressure on the tibia, together with bending of the foot in the direction in which the dislocation was produced. A coincident fracture of one or other malleolus is without much importance. A pure lateral dislocation without fracture is impossible.

B. *Subastragalar dislocation* may occur either in the

inward direction from forced inversion, or outward from eversion of the foot. The diagnosis may offer considerable difficulty. In any doubtful case an anæsthetic should be given, and the latter aid, with full relaxation of the muscles, is necessary in order to effect reduction by appropriate traction and direct pressure.

c. *Dislocation of the astragalus alone.*—This may occur in several directions. The mechanism of its production is complicated, and not at present fully understood. The diagnosis is fairly easy owing to the projection of the astragalus under the skin and the approximation of the tibia to the other tarsal bones, *i. e.* it may articulate directly with the os calcis. Reduction is difficult, and in any case where other methods fail, both in dislocation of the astragalus and the subastragalar form, the surgeon should operate. It is noteworthy that aseptic incision, &c., has given good results, although the astragalus may have had its vascular and ligamentous connections seriously damaged.[1]

Fracture of the astragalus is extremely rarely an injury confined to this bone. Thus, for instance, in severe cases of fracture of the os calcis the astragalus may give way, especi-

[1] Although the distinction between subastragaloid dislocation and that of the astragalus itself is a clear one, it sometimes happens that the foot is displaced (generally inwards) from the astragalus, whilst the latter bone is also partially displaced at its upper articulation. Of this mixed form there is a specimen in the London Hospital Museum. There is yet another variety, in which with a subastragaloid dislocation the neck or other part of the astragalus itself is fractured. Sir William MacCormac narrates a case of this in a paper in 'St. Thomas's Hospital Reports' (see also Pollock, 'Med.-Chir. Trans.,' vol. xliii; and Broca, Soc. de Chir., 1860). M. Broca collected seventy-eight cases of simple dislocation of the astragalus and eighty cases of compound dislocation. In the great majority of these reduction was impossible, and the astragalus had to be excised. Out of eighty-six operations primary excision of the bone was performed fifty-nine times with seventeen deaths, secondary excision twenty-seven times without a death. According to Sir William MacCormac it is important to aim at ankylosis between the tibia and the os calcis, lest the foot should be too weak. There is no doubt that many cases recorded as dislocation of the astragalus have really been examples of subastragaloid dislocation. In cases of either, where, under thorough anæsthesia and relaxation of the calf muscles by flexion of the knee, reduction still cannot be effected, the tendo Achillis should be divided. The tibialis posticus may also be a serious obstacle to reduction, and may also require division.—J. H.

Fig. 1a

Fig. 1

Fig. 2a

Fig. 2

Lith. Anst. v. F. Reichhold. München

PLATE LXVIII.

DISLOCATIONS AT THE ANKLE-JOINT.

Figs. 1 and 1 *a*.—Backward displacement of the foot, the peroneal tendons being placed between the astragalus and the external malleolus, and the foot apparently shortened whilst the heel projects abnormally.

Figs. 2 and 2 *a*.—Forward dislocation of the foot, the front part appearing to be lengthened whilst the heel does not project to the normal extent.

ally at its neck, and parts of this bone may be detached or bent in by the same force that leads to a dislocation at the ankle-joint. The diagnosis may offer considerable difficulty, the chief points to be noticed being alteration in the shape of the foot, abnormal projection at its dorsum, pain on pressure over the neck and head of the bone, filling up of the "sinus tarsi," limitation of movement, especially in dorsal flexion. Measurement with the callipers may also show differences on comparison with the sound foot.

Fracture of the os calcis.—One has to distinguish between fracture of the body of the bone and that of its processes, the latter including the projection of the heel and the sustentaculum tali. Fracture from compression of the bone (see Fig. 130) results from a fall upon the foot, or from alighting

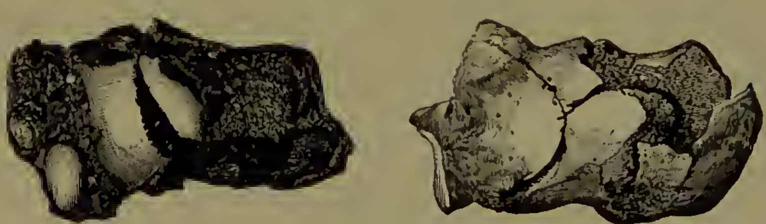

Fig. 130.—Comminuted fracture from compression of the os calcis, produced artificially.

awkwardly when jumping. It has hence been chiefly met with amongst house painters, masons, mountain climbers, &c. The os calcis is crushed between the ground and the astragalus, and besides a longitudinal fracture there may be numerous other fissures in the bone, which may, indeed, be quite comminuted. In such severe cases the symptoms are characteristic. The os calcis is widened, flattened, and painful; the malleoli, especially the inner one, are approximated to the ground, and an appearance of flat-foot is given (see Fig. 131). Mobility of the ankle-joint may be unaffected; on the other hand, the inversion and eversion movements are certain to be impaired. Sometimes the fracture occurs in both feet. The diagnosis is more easy in old cases than in recent ones, on account of the formation of callus and secondary changes. Cases of it are much more common than was formerly thought, since they were readily mistaken for those

of severe sprains. The diagnosis demands careful examination, and we may note amongst the symptoms which are sooner or later observed—

1. Increase of width of the heel (up to 2 cm.).
2. Filling up of the normal hollows on either side of the tendo Achillis from œdema.
3. Atrophy of the calf muscles.
4. Marked impairment in walking power.
5. Persistent tenderness of the foot.
6. Abnormal contour, especially depression of the malleoli.

The prognosis of this fracture is not very favourable, even if it be recognised early; the function of the foot may be permanently damaged, and this is the more likely to occur since recent observations have shown that neighbouring bones (the astragalus and malleoli) are not infrequently implicated at the same time. In the treatment, when it is possible, the fragments should be got into position and fixed there for a long period in order to avoid flat-foot supervening. In the early stages it is dangerous to employ much compression for fear of fat embolism; at a later stage compression and massage with passive motion, &c., should be thoroughly employed.

FIG. 131.

FIG. 132.

Fig. 131.—Comminuted fracture of the left os calcis resulting from a fall on the foot.

Fig. 132.—Fracture of the os calcis with upward displacement of the heel fragment. The sketch was made four weeks after the injury. A subsequent operation resulted in good union.

The projecting part of the os calcis forming the heel may be detached by a sudden pull of the calf muscles, may be broken off by direct violence, or as part of a complicated fracture of the whole bone. The fragment will be drawn upwards by the calf muscles. It may be replaced when the knee is fully bent, and should be fixed in position with the aid of steel needles. The limb is then put up with the knee flexed and the foot hyper-extended. Under certain circumstances it might even be advisable to divide the tendo Achillis obliquely, and suture it again so as to elongate the tendon and enable the fragment of bone to be secured to the rest of the os calcis.

Fracture of the sustentaculum tali.—By this is meant a breaking off of the process of bone on the inner side of the os calcis, which helps to support the astragalus and is grooved by the flexor longus hallucis. If it is fractured we find marked pain on pressure, the astragalus is depressed downwards and inwards, the foot is in a position of valgus, and the movements of ab- and adduction of the foot are much impaired. In old cases we find bony thickening below the internal malleolus—due, as has been proved by dissection, to the detached fragment uniting with the astragalus.

Isolated fracture of the sustentaculum is rare. It may occur during a slip in descending a stair, in a fall from a horse, or in jumping. More commonly it happens as a complication of fracture of the internal malleolus, or of the rest of the os calcis.

Isolated fractures of the remaining tarsal bones are extremely uncommon. Those of the metatarsus and phalanges have no great practical importance, and are easy both to diagnose and treat.

Dislocations of the Foot.

The distal row of tarsal bones are but rarely dislocated, but one or other may be partially or completely displaced. This condition may be recognised by careful palpation after the swelling of the foot has gone down under the influence of massage, &c. Reduction may be very difficult, and an operation either to replace and fix with suture the displaced bone, or to excise it, may be indicated.

Dislocation of the metatarsal bones occurs particularly in the form of an upward displacement of all or nearly all the metatarsals at their tarsal articulation.[1] There is, of course, abnormal bony projection on the dorsum with hollowing of the plantar surface. Reduction is difficult, and in old cases can only be effected by operation.

Dislocation of the phalanges, analogous to those of the fingers, is occasionally met with, due to forced hyper-extension. The diagnosis is easy, and reduction is effected in the same manner as in the case of the fingers.

[1] An interesting example of this dislocation, that of all the metatarsal bones upwards and outwards at their bases, was under my observation two years ago. The patient, a man aged twenty-three, had fallen with his horse, the weight of the latter coming largely on the right foot. There was such excessive swelling of the whole foot for a considerable time that the dislocation was not detected. When this swelling had gone down and I saw the foot at the end of two months, the following condition was present:

1. The internal cuneiform bone projected strongly downwards and inwards when compared with the first metatarsal.

2. There was a ridge along the whole dorsum of the foot corresponding to the tarso-metatarsal joint, and the foot was broader at its centre than on the other side.

3. The second metatarsal was abnormally mobile at its proximal end (it will be remembered that it is fixed rigidly between the three cuneiforms).

4. The base of the fifth metatarsal bone was displaced outwards, and half an inch nearer the external malleolus than on the other side. The foot was not greatly deformed, and the man was beginning to walk fairly well, but at the same time some impairment would probably always persist. The condition did not seem quite to justify an operation, without which any attempt at reduction would be quite useless. Remembering how firmly the second metatarsal is fixed in its place, probably with greater security than any other long bone in the body, a true dislocation of it with the other metatarsal bones such as has just been instanced, might seem incredible.—J. H.

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